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Biological and Systematic Studies on the Subgenus *Neotrombicula* (Genus *Trombicula*) in the Central United States (Acarina, Trombiculidae) *

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ABSTRACT: This paper consists of studies of larval chigger mites of the subgenus *Neotrombicula* from the central United States. A key to all species known in this country is included, and two new species are described. *Trombicula* (*Neotrombicula*) *autumnalis*, hitherto known from Europe, is recorded from America for the first time.

Long series of specimens were examined whenever possible and considerable data on variations within populations and on geographical variations are presented. This is particularly important since much of the previous work on chiggers has been done with very inadequate series of specimens even when long series were available. *T. microti* and *T. harperi* were found to behave as distinct species even though so similar that a few specimens could not be placed with certainty in one species or the other. *T. lipovskyi* and *T. whartoni* were also found to be distinct sympatric species although very closely related. Certain characters which distinguish them in one area are of little value in another area where other characters are more useful. *T. whartoni* is restricted to moist, usually woodland areas while *T. lipovskyi* is found both in such areas and in dry treeless regions.

Data on hosts and seasonal activity are provided for each species treated. Some of the other ecological requirements can often be inferred from the places where host animals were obtained and are presented whenever pertinent. Further biological data is provided for certain species, particularly *T. lipovskyi* and *T. sylvilagi*. Like other species of *Neotrombicula* occurring in the Kansas region, these forms are active as larvae in fall and winter. Larvae of the first are abundant in Kansas from October through December, become scarce in late December, January, and February, and show a lesser peak of activity again in March and April. Larvae of *T. sylvilagi* are active in the same area from the last half of August to the first half of December. Both species, and perhaps all "winter chiggers," have but one generation per year, in contrast to at least some of the forms whose larvae are active in summer (*e. g.*, *T. alfreddugèsi*). In *T. lipovskyi* engorged larvae dropping from hosts in November became nymphs under outdoor temperatures from April to July and the first adults appeared in late June.

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INTRODUCTION

This paper comprises taxonomic, ecological, and biological studies on the known chiggers of the subgenus *Neotrombicula* Hirst from the states of Utah, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Missouri, and Arkansas. Material from other areas was examined for comparison. The taxonomic studies of larvae were based almost entirely on specimens in the University of Kansas Snow Entomological Museum. In the descriptions of new species, the description is based on the holotype with differences occurring in the paratypes indicated in parentheses. Under the heading, additional records, is included information on previously published records from the states concerned. All scutal measurements are included in table 8. The terminology used in this paper follows that proposed by Wharton *et al* (1951). The ecological and biological studies were largely confined to those species occurring in northeastern Kansas (particularly Douglas County), although host and habitat data are provided for other areas.

The larval chiggers of the subgenus *Neotrombicula* were taken only from birds and mammals although many reptiles have been examined from areas where *Neotrombicula* is common. These hosts were obtained by shooting, in the case of birds and larger mammals, and snap or live trapping for smaller mammals. Each specimen (or specimens) of each species from each locality was assigned a field number which correlates it with all recorded data. The birds and mammals were placed according to field number into separate bags. In the laboratory the bags were placed in the refrigerator and kept there at approximately 40° F. from one to several days. The animals were then removed, usually examined to determine the location of the chiggers, and warmed at room temperature for one to two hours. Following this they were washed two or three times in a solution of synthetic detergent and water. The solution was then decanted. The residue was examined under a dissecting microscope and the larval chiggers were recovered and sorted. The animals were always examined after washing, particularly in the ears, to find and recover any remaining chiggers. This washing method is discussed in detail by Lipovsky (1951b). However, some hosts, particularly those from the Rocky Mountain region, were superficially examined and the chiggers were removed and preserved in the field. Mammals which were live-trapped were placed in screen cages over pans containing a synthetic detergent in water, which caught the fully engorged chiggers as they dropped

from the host. After recording the numbers and kinds recovered from each host, the chiggers were either preserved in from 75 to 85 percent ethyl alcohol or were reared.

The number of each species of chigger from each host was determined either immediately after removal from the hosts or after preservation. When only a few chiggers were recovered they were all mounted. However, whenever larger numbers were recovered, the *Neotrombicula* were separated from the other genera and subgenera by characters seen with the aid of a dissecting microscope at 96 power. The color of the living *Neotrombicula* was usually red (unengorged) to relatively bright orange (engorged). One specimen of *Trombicula whartoni*, however, was bright yellow. This character cannot be used with preserved specimens as they lose their color. The other characters visible with a dissecting microscope include the relative size and body shape, the flagelliform sensilla, the five scutal setae, the long nude setae on leg III, and the relatively longer and fewer body setae (especially when compared to the *Euschöngastia* of northeastern Kansas). The number of each species of *Neotrombicula* was estimated by mounting approximately 20 representatives.

The specimens examined in the University of Kansas Snow Entomological Museum (listed as KU, with the slide number) were mounted in a mixture of polyvinyl alcohol and lacto-phenol (PVA-LP) as described by Lipovsky (1953b).

A phase contrast microscope was used for all measurements and other detailed microscopic work. The illustrations were made with the aid of a camera lucida. Whenever possible, scutal measurements were made on unengorged or slightly engorged specimens.

ACKNOWLEDGMENTS

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The majority of the hosts of *Neotrombicula* larvae were collected and identified by Mr. Robert B. Finley, Jr., and Mr. Richard B. Loomis, while other hosts were taken by Mr. L. J. Lipovsky and other members of the chigger project as well as staff members and graduate students in the Departments of Entomology and Zoology at the University of Kansas. Dr. Cluff Hopla of the University of

Oklahoma, Department of Zoological Sciences, generously supplied us with the Utah chiggers, and many of the Oklahoma hosts.

Thanks are also extended to Dr. Henry S. Fitch for permission to carry on the ecological studies at the University of Kansas Natural History Reservation.

For the loan of pertinent material I wish to thank Dr. Edward W. Baker of the Bureau of Entomology and Plant Quarantine, Dr. James M. Brennan of the Rocky Mountain Laboratory, and Dr. George W. Wharton of Duke University.

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SYSTEMATIC AND BIOLOGICAL ACCOUNT

Subgenus NEOTROMBICULA Hirst

Neotrombicula Hirst, 1925, Nature, vol. 116, p. 609.
Type of subgenus: *Acarus autumnalis* Shaw, 1790.

The subgenus *Neotrombicula* includes all species of *Trombicula* having the following larval characters: more or less pentagonal scutum; leg III with one or more mastitarsalae, tibia and telofemur III with long nude (mastitibiala and mastifemorala III) or long plumose setae; a single feathered seta present on each coxa; sternal setae arranged 2-2; palpal claw with three prongs.

Brennan and Wharton (1950:156) separated *Neotrombicula* into several groups based on the number and arrangement of the long nude setae on leg III; these are the "autumnalis" group, the "microti" group, the "bisignata" group, and the remaining ungrouped species. The characteristics of these groups are given in table 1.

TABLE 1

Characteristics of the Groups of *Neotrombicula*

	Autumnalis group	Bisignata group	Microti group	Ungrouped species		
mastitarsala III	1	3	2	2	2	3
mastitibiala[1] III	0	1	1	1	2	1
mastifemorala[1] III	0	0	1[2]	0	0	1

1. In the cases where there are no mastifemorala or mastitibiala III present there are long plumose setae in their places.

2. Basal barbs are occasionally present on the mastifemorala III of *californica*, *goodpasteri*, and *richmondi*.

KEYS TO THE NEOTROMBICULA OF THE UNITED STATES [3]

(Modified from Brennan and Wharton, 1950)

autumnalis group

Only one species known in the United States ..... *autumnalis* *

bisignata group

1. Seta on palpal femur nude ..... *eusignata*
   Seta on palpal femur branched or feathered 2
2. Seta on palpal genu nude; first dorsal posthumeral row usually with six (occasionally seven) setae ..... *subsignata* *
   Seta on palpal genu branched; first posthumeral row usually with eight (occasionally seven) setae ..... *bisignata*

microti group

1. Leg I with three genualae ..... *dinehartae*
   Leg I with one or two genualae 2
2. Seta on palpal genu nude, on femur usually nude 3
   Seta on palpal genu and on femur branched or feathered 6
3. Sensilla nude; seta on palpal femur nude or branched ..... *californica*
   Sensilla with at least minute barbs; seta on palpal femur nude 4
4. Sensilla with minute basal barbs; first posthumeral row with 10 to 14 setae; dorsal setae more than 40 ..... *browni* *
   Sensilla with pronounced barbs along most of its length; six to nine (rarely ten or eleven) setae in the first posthumeral row; dorsal setae less than 40 5
5. Galeal seta nude, occasionally one with a single branch. Usually with eight or nine setae in the first posthumeral row ..... *harperi* *
   Galeal seta with one to several branches. Usually with six setae in the first posthumeral row ..... *microti* *
6. Galeal seta branched 7
   Galeal seta nude 10
7. Sensilla with several pronounced apical branches ..... *loomisi* *
   Sensilla nude or with barbs, never with only pronounced apical branches 8
8. Scutum distinctly flattened posteriorly; sensilla nude or with indistinct basal barbs ..... *cavicola*
   Scutum usually rounded posteriorly; sensilla with distinct barbs present 9
9. Sensilla with short barbs on basal half only; ratio of posterolateral seta (PL) to anterolateral seta (AL) of scutum, .6 to .8 ..... *jewetti*
   Sensilla with pronounced barbs along most of its length; ratio PL to AL .9 ..... *finleyi* *
10. Leg I with one genuala ..... *richmondi* *
    Leg I with two genualae 11
11. Humeral setae total three or more ..... *goodpasteri*
    Humeral setae total two 12

3. Species discussed in this paper are marked with an asterisk.

12. Scutum with few and scattered punctae, posterior margin angular; sensilla usually with few minute basal barbs. (Scutal punctae more numerous and sensillae with pronounced barbs on basal half in Arkansas and Mississippi specimens, as shown in figures 19-22.), *whartoni* *

Scutum with numerous and evenly distributed punctae, posterior margin broadly rounded; sensilla with pronounced barbs along most of its length ..... *lipovskyi* *

Ungrouped Species

1. Seta on palpal femur and on genu nude; leg I with three genualae; two mastitibialae III present ..... *sylvilagi* *

Seta on palpal femur and on genu feathered; leg I with one or two genualae; one mastitibiala III present 2

2. Galeal seta branched; leg III with mastifemorala ..... *varians*

Galeal seta nude; leg III without mastifemorala 3

3. Leg I with two genualae; lateral seta on palpal tibia nude .. *waynensis*

Leg I with one genuala; lateral seta on palpal tibia feathered 4

4. Dorsal setal formula beginning 4-4 ..... *farrelli* [4]

Dorsal setal formula beginning 2-6 ..... *carterae* [4]

AUTUMNALIS GROUP

The "autumnalis" group is regarded by the writer to be restricted to those species of *Neotrombicula* that have only a single long, nude seta (mastitarsala) on leg III. The only species of this group known from North America is *T. autumnalis*, or a form whose larvae seem indistinguishable from it. It is here recorded from the Western Hemisphere for the first time. *T. autumnalis* is otherwise known only from Europe, and does not seem to occur in eastern Asia. Its appearance in North America is therefore most surprising.

Trombicula (*Neotrombicula*) *autumnalis* (Shaw)

Figures 3-6. Tables 4 and 8.

Acarus autumnalis Shaw, 1790, Nat. Misc., vol. 2, p. 42.
Trombicula autumnalis, Kneissl, 1916, Zool. Anz., vol. 46, p. 253; Richards, 1950, Parasitology, vol. 40, pp. 105-117, "lectotype" [= neotype], Birkshire, England, Fair Mile, Warren Farm, Streatley, Oct. 2, 1946, British Museum (Natural History).
Trombicula (*Neotrombicula*) *autumnale*, Hirst, 1925, Nature, vol. 116, p. 609.
Trombicula (*Neotrombicula*) *autumnalis*, Hirst, 1926, Ann. Appl. Biol., vol. 13, pp. 140-143. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, pp. 56-58 (includes a comprehensive synonymy).

Diagnosis. Based on the American specimens. A member of the "autumnalis" group with the following larval characters: palpal femur with feathered seta, genual and ventral tibial setae branched, both dorsal and lateral tibial setae nude; three genualae I; six setae present in each of first and second posthumeral rows.

4. The writer questions the validity of the basis of the separation of the two species.

Geographic range. This species is known from Europe (see Wharton and Fuller, 1952:56-57) and North America; southwestern Colorado (Dolores County) and southwestern Nebraska (Dundy County).

Seasonal occurrence. North America: Colorado, Oct. 18; Nebraska, Nov. 1.

The following is a description of the American specimens.

Body. Unengorged or slightly engorged specimen (KU 5803), length 304 μ, width 197 μ. Eyes two on each side, subequal. Color in life deep red (Nebraska specimens).

Gnathosoma. Palpal coxa with feathered seta; femur with dorsal feathered seta; genu with dorsal branched seta; tibia with dorsal and lateral setae nude, ventral seta branched; tarsus with spur, subterminala, single robust feathered dorsal and six feathered ventral setae. Galeal seta nude.

Legs. Leg I: coxa, trochanter, basifemur with one feathered seta each; telofemur with five feathered setae; genu with three genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala, and eight feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately twenty feathered setae. Leg II: coxa and trochanter with one feathered seta each; basifemur with two feathered setae; telofemur with four feathered setae; genu with one genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately fifteen feathered setae. Leg III: coxa and trochanter with one feathered seta each; basifemur with two feathered setae; telofemur with three feathered setae (inclusive of the long plumose seta as shown in fig. 6); genu with genuala and three feathered setae; tibia with tibiala and six feathered setae (includes the long plumose seta as in fig. 6); tarsus with mastitarsala and approximately thirteen feathered setae.

Scutum. Posterior angle rounded. Punctae small, numerous, evenly distributed. Sensillary bases anterior to the bases of anterolateral setae. Sensillae of Nebraska specimens with approximately six to nine distinct branches on the apical two thirds; Colorado specimen with seven shorter branches on an apical fragment (fig. 3). For scutal measurements see table 8.

Setae. Dorsal body setal formula of ten specimens from Nebraska 2-6-6 + 22 to 29 (mean 27), one specimen from Colorado 2-6-6 +

25; ventral setae, from Nebraska 2-2-30 to 38 (mean 34), from Colorado, 2-2-34; total body setae, Nebraska 74-84, Colorado 77.

Remarks. The larval specimens from America are indistinguishable from the specimens examined from England. On the basis of Richard's key (1950a:116) for separating the "five main types of harvest mite larvae found in Great Britain" the American specimens would be classified as "normal type b." Furthermore, the American specimens are similar to Richard's (1950a:116) description of the lectotype [=neotype] in having a simple galeal seta, a single pair of humeral setae, and six setae in the first and second posthumeral rows.

The sensillary branches of the specimens from Nebraska (fig. 4) are elongate, similar to the English specimens, while the apical fragment of a Colorado specimen (fig. 3) indicates more numerous but shorter branches. On the basis of the larval characters studied, these specimens are considered to be *T. autumnalis.* However, it is possible that differences between the European and American forms may be found in other stages.

Richards (1950a and b) reported the variations occurring in what he defines as *T. autumnalis,* in Great Britain. After examining the data presented by Richards, I am in agreement with Womersley (1952:365) who stated that ". . . some of the variations suggest that at least two species occur in Britain."

Ecology. In Dundy County, Nebraska, Richard B. Loomis reports that the hosts were trapped along Rock Creek in isolated wet meadows, which are fed by continuously flowing springs. These meadows are situated in or adjacent to a tall grass marshy habitat, in strong contrast to the dispersed clumps of short grasses and yucca on the very dry sandy soil surrounding the valley. A few willows were situated near the meadows along the creek.

Most of the specimens of *T. autumnalis* from hosts collected in Dundy County, Nebraska, were found in the ears. Only seven of the 68 specimens were partially or fully engorged. The large number of unengorged and slightly engorged *autumnalis* indicates that the collection date, November 1, 1952, was early in the season and strongly suggests that this is a fall and winter chigger in this locality.

In Dolores County, Colorado, R. B. Finley, Jr. reports that the nest of the host, *Neotoma cinerea,* was situated among rocks within open woods. The trees were primarily aspen with scattered western yellow pines (*Pinus ponderosa*). The principal shrubbery within 100 feet of the nest (the approximate range of *Neotoma* from the

nest, according to Finley) included scrub oak (*Quercus gambellii*), choke cherry (*Prunus virginianus*), serviceberry (*Amelanchier* sp.) and *Galium* sp. Approximately 100 feet from the nest was a hollow characterized by a moist, dark loam soil; irises were present in the hollow. The whole area was moderately shaded.

Specimens examined. Total number 72, as follows: Colorado—*Dolores County:* 15 mi. N, 10 mi. E Dolores, *Neotoma cinerea,* Oct. 18, 1949, KU 4003-4. Nebraska—*Dundy County:* 5 mi. N, 2 mi. W Parks, Rock Creek Fish Hatchery, *Microtus ochrogaster,* KU 5821-75—*Microtus pennsylvanicus,* KU 5809-20—*Reithrodontomys megalotis,* KU 5808, all collected Nov. 1, 1952. Great Britain—*Skomer Island:* Pembrokershire, *Puffinus puffinus,* Sept. 14, 1947, 1. *Wales:* Guilsfield without Montgomeryshire, *Orcytolagus cuniculus,* 1.

Bisignata Group

This group is represented in North America by three species only, of which only *T. subsignata* is known from the states included in this paper.

Trombicula (*Neotrombicula*) *subsignata* Brennan and Wharton

Tables 4 and 8

Trombicula (*Neotrombicula*) *subsignata* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 159-161, type: USNM no. 1837, Broome Co., N. Y., *Microtus pennsylvanicus,* Aug. 10, 1947. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

Diagnosis. A member of the "bisignata" group with the larval characters as follows: palpal femoral seta branched, genual and dorsal tibial setae nude; first posthumeral row usually with six, occasionally with seven setae.

Geographic range. This species is known from Montana (Ravalli County) south to Colorado (Boulder County); North Dakota (Morton County); Missouri (Taney County); Pennsylvania (Wayne and Warren Counties) to New York (Broome County).

Seasonal occurrence. In the Rocky Mountain region the earliest record of this species is June 12 (Ravalli County, Montana, Brennan and Wharton, 1950:161); the latest record is August 15 (Boulder County, Colorado).

Remarks. Of five specimens examined from Boulder County, Colorado, one (KU 4141) had both palpal genual setae forked, another (KU 4143) had only one forked, the other three (as well as the specimens examined from the other areas) had both setae nude. Six setae were seen in the first posthumeral row in all but

three of the specimens examined; the specimen from Carbon County, Wyoming had seven setae, while two specimens from Boulder County, Colorado had this character obscure.

Specimens examined. Total number 9, as follows: WYOMING—*Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Zapus princeps,* July 24, 1947, KU 4138. COLORADO—*Boulder County:* 12½ mi. E Estes Park, 8400 ft., KU 4139-40; 1 mi. SE Ward, KU 4141-43; 3 mi. NE Nederland, KU 4144; all from *Citellus lateralis,* collected August 6-15, 1947. MISSOURI—*Taney County:* 1½ mi. SW Forsyth, *Capella gallinago,* Sept. 7, 1947, KU 4025. NEW YORK—*Broome County:* 6 mi. N Binghamton, *Microtus pennsylvanicus,* Aug. 10, 1947, KU 4145 (Topotype).

MICROTI GROUP

This is the largest group of the subgenus, containing fourteen species in North America. With the exception of three, species of this group have two humeral setae and two genualae I. The three species are *T. goodpasteri,* which has more than two humeral setae, *T. richmondi,* with a single genuala I, and *T. dinehartae,* which, according to Brennan and Wharton (1950:179), has three genualae I. Of the fourteen species, eight are known from the states included in this paper.

Trombicula (*Neotrombicula*) *microti* Ewing

Tables 3-4, 8-9

Trombicula microti Ewing, 1928, Proc. Ent. Soc. Washington, vol. 30, no. 5, p. 80, type; USNM no. 984, Lincoln Co., Wyo., Gravel Creek, tributary of Pacific Creek, *Microtus richardsoni macropus,* Aug. 13, 1927, coll. O. J. Murie; 1931, Proc. U. S. Nat. Mus., vol. 80, Art. 8, p. 9; 1937, Proc. Biol. Soc. Washington, vol. 50, p. 171. Radford, 1942, Parasit., vol. 34, p. 57. Wharton, 1946, Proc. Ent. Soc. Washington, vol. 48, p. 176. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 431. Thor and Willmann, 1947, Das Tierreich, lief. 71b, p. 268. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56.

Trombicula parkeri Radford, 1942, Parasitology, vol. 34, p. 62, type; Conejos Co., Colo., Antonito, *Ochotona princeps* or Cony, Sept. 9, 1930, British Museum (Natural History); 1946, Proc. Zool. Soc. London, vol. 116, p. 587; 1947, Proc. Zool. Soc. London, vol. 117, p. 275. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56. Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, pp. 167-168.

Trombicula (*Neotrombicula*) *microti,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 164-169. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

Diagnosis. A member of the "microti" group with the larval characters as follows: seta on palpal femur and on genu nude; both galeal setae with one or more branches; first posthumeral row usually with six (occasionally seven) setae, less than 40 dorsal body setae; sensilla with pronounced barbs on the apical two thirds.

Geographic range. This species is known from the Pacific coastal states of Washington (King County) south to California (Mono County); in the Rocky Mountain region from Alberta (Edmonton), Canada south to New Mexico (Catron County); in the east from Pennsylvania (Wayne and Monroe counties) north through eastern Canada to Labrador (Goose Bay).

Seasonal occurrence. In the Rocky Mountain region this species has been taken as early as July 19 (San Juan County, Colorado), and as late as October 25 (Ravalli County, Montana, Brennan and Wharton, 1950:166).

Remarks. The specimens of *T. microti* examined had both galeal setae branched at least once, usually twice or more.

The first posthumeral row had six setae in 18 of 19 specimens from Wyoming and Colorado, and 35 of 40 specimens examined from Utah; the others possessed seven setae.

The parasubterminalae were both nude and branched. Eleven of thirteen specimens from Colorado and Wyoming had setae nude, while each of the other two had a single branched parasubterminala. Fourteen of 24 Utah specimens had one parasubterminala branched, nine had both nude, and one had both branched.

Specimens examined. Total number 98, as follows: Montana—*Ravalli County: Neotoma* sp., KU 4112—*Tamiasciurus* sp., KU 4113, all collected Aug. 12 and 17, 1945. Wyoming—*Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Microtus longicaudus,* KU 4122-24—*Microtus montanus,* KU 4119-20—*Phenacomys intermedius,* KU 4022, 4115-17—*Zapus princeps,* KU 4114, 4118, all collected July 23-25, 1947. Utah—*Summit County:* Uinta Mts., Boulder Mt., 10,900 ft., *Ochotona princeps,* Aug. 2, 1952, KU 4032-4100. Colorado—*Rio Blanco County:* 5 mi. S Pagoda Peak, 9100 ft., *Microtus* sp., July 28, 1947, KU 4126-27; 1 mi. NW Pagoda Peak, 10,400 ft., *Ochotona princeps,* July 28, 1947, KU 4125, 4128-29, 4397. *Gunnison County:* 3 mi. S, 6½ mi. E Crested Butte, 9200 ft., *Neotoma cinerea,* Aug. 10, 1948, KU 4013, 4131-33, 4135. *San Juan County:* 6½ mi. SW Silverton, 10,100 ft., *Neotoma cinerea,* July 19, 1949, KU 4136. Pennsylvania—*Monroe County: Pitymys* sp., Sept. 13, 1949, 2, Duke Univ. Maine—*Cumberland County:* Brunswick, *Tamiasciurus hudsonicus,* Sept. 21, 1951, KU 4137. Canada—*Ontario:* Quetico, *Clethrionomys gapperi,* July, 1933, KU 4026.

Additional records. Brennan and Wharton (1950:166-167): Wyoming—*Lincoln County: Microtus richardsoni,* August 13, 1927, type specimen. *Albany County: Ochotona princeps,* Aug. 29, 1946,

2. COLORADO—Rocky Mt. Natl. Park, *Microtus* sp., Sept. 8, 1948. *Conejos County: Ochotona princeps,* Sept. 9, 1931.

Trombicula (Neotrombicula) harperi Ewing

Tables 2-4, 8-9

Trombicula harperi Ewing, 1928, Proc. Ent. Soc. Washington, vol. 30, no. 5, p. 79, type: USNM no. 983, Essex County, N. Y., Heart Lake, *Napeozapus insignis,* Summer, 1926, coll. F. Harper; 1931, Proc. U. S. Nat. Mus., vol. 80, art. 8, p. 8. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56.

Eutrombicula harperi, Ewing, 1938, Jour. Washington Acad. Sci., vol. 28, p. 294. Radford, 1942, Parasitology, vol. 34, p. 67. Knight, 1951, Canad. Ent., vol. 83, no. 10, pp. 279-280.

Trombicula (Eutrombicula) harperi, Thor and Willmann, 1947, Das Tierreich, lief. 71b, p. 285.

Trombicula (Neotrombicula) harperi, Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, pp. 170-172. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 58.

Diagnosis. A member of the "microti" group with the larval characters as follows: seta on the palpal femur and on genu nude; galeal setae nude (occasionally one with a single branch); usually eight or nine setae in the first posthumeral row, less than 40 dorsal body setae; sensilla with pronounced barbs along most of its length.

Geographic range. This species is known from British Columbia, (Vancouver, Knight, 1951); the Rocky Mountain region from Montana (Missoula County) and Idaho (Lemhi County) to Wyoming (Washakie County) and Colorado (La Plata and Conejos counties); and in the east from Pennsylvania (Beaver and Monroe counties) to Maine (Piscataquis County).

Seasonal occurrence. In the Rocky Mountain region this species has been taken as early as June 11 and as late as August 20 (both records from Ravalli County, Montana, Brennan and Wharton, 1950:171).

Remarks. Among the specimens of *T. harperi* examined, the galeal setae were normally nude, however, 21 specimens had a single branch occurring on one seta. Usually the larvae had one or both parasubterminalae branched. The variation in the number of setae of the first posthumeral row is summarized in Table 2.

Some of the anomalous characters occurring on the specimens examined are as follows: Two specimens had a duplication of the anteromedian scutal seta (AM); on one specimen (KU 4391, Rio Blanco County, Colorado) the AM's were arranged laterally, on the other (KU 4586, San Juan County, Colorado) they were arranged medially. A single specimen (KU 4437, Boulder County, Colorado) had three mastitarsalae III on one leg, while the other leg had the normal number of two, and a single specimen (KU 4569, San Juan

TABLE 2

The Number of Setae in the First Posthumeral Row of *T. harperi*

	7		8		9		10		11	
	No. spec.	Pct. of series	No. spec.	Pct. of series	No. spec.	Pct. of series	No. spec.	Pct. of series	No. spec.	Pct. of series
Washakie County, Wyo.	1	2%	45	68%	19	29%	1	2%	.....	%
Carbon County, Wyo.	1	2	43	65	17	26	4	6	1	2
Rio Blanco County, Colo.	.....	.....	37	62	18	30	5	8	.....	.....
Boulder County, Colo.	5	4	106	83	15	12	2	2	1	1
San Juan County, Colo.	3	7	30	65	10	22	3	7	.....	.....
Total	10	4	261	71	79	22	15	4	2	0.5

County, Colorado) had two setae, lateral and dorsal, on each palpal genu.

Preliminary studies indicate that the scutal measurements of *T. harperi* are larger in the south, smaller in the north. The posterolateral seta (PL) was selected as an indicator of size differences between local populations. The results are summarized in Table 9.

In the Colorado-southern Wyoming region the means of the PL lengths vary from 64 μ in San Juan County, southwestern Colorado to 60 μ in Carbon County, south central Wyoming. In Washakie County (Big Horn Mountains) of north central Wyoming the PL mean was 55 μ. This is significantly smaller than those from Carbon County and is consistent with the fact that the Big Horn Mountains are isolated from the Southern Rocky Mountain region.

In Rio Blanco County, Colorado, little difference was indicated in the PL mean between specimens from 7700 feet (64.1μ) and 10,400 feet (62.5μ), however, the PL measurements from the higher elevation tends to be somewhat smaller than that of the lower elevation, as expected.

Specimens examined. Total number 480, as follows: WYOMING—*Washakie County:* 9 mi. E, 4-5 mi. N Ten Sleep, 7000-7400 ft., *Clethrionomys gapperi,* KU 4213-15, 4217-37, 4239-58, 4319—*Microtus longicaudus,* KU 4216—*Peromyscus maniculatus,* KU 4191-4205, 4318—*Tamiasciurus hudsonicus,* KU 4206-12, 4238—*Zapus hudsonius,* KU 4146, 4259, all collected July 14-18, 1947. *Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Clethrionomys gapperi,* KU 4021, 4316-17—*Microtus longicaudus,* KU 4121-24, 4260-4314—*Microtus montanus,* KU 4119-20, 4162-74—*Phenacomys intermedius,* KU 4115-17, 4175—*Zapus princeps,* KU 4118, 4138, 4147-61, 4190, 4315, July 23-25, 1947. COLORADO—*Rio Blanco County:* 5 mi. S Pagoda Peak, 9100 ft., *Microtus* sp., KU 4352-53; 1 mi. NW Pagoda Peak, 10,900 ft., *Ochotona princeps,* KU 4354-97; 9½ mi. SW Pagoda Peak, 7700 ft., *Peromyscus maniculatus,* KU 4340-51—*Zapus princeps,* KU 4320-39, all collected July 27-29, 1947. *Boulder County:* 12½ mi. S Estes Park, 8400 ft., *Clethrionomys gapperi,* KU 4510-44—*Citellus lateralis,* KU 4134, 4493-4504—*Microtus longicaudus,* KU 4423-89—*Neotoma cinerea,* KU 4505-09—*Peromuscus maniculatus,* KU 4491-92—*Zapus princeps,* KU 4490, all collected Aug. 6-8, 1947; 3 mi. S Ward, 9000-9400 ft., *Citellus lateralis,* KU 4398-4405, 4422—*Phenacomys intermedius,* KU 4406-21, all collected July 31-Aug. 1, 1947; 3 mi. N Nederland, *Citellus lateralis,* KU 4546—*Junco hyemalis,* KU 4545, all collected Aug. 15, 1947.

Douglas County: 7 mi. N, 4 mi. W Castle Rock, *Neotoma mexicana fallax,* Aug. 4, 1948, KU 4111, 4554-4556. *Gunnison County:* 3 mi. S, 6½ mi. E Crested Butte, 6400 ft., *Neotoma cinerea,* Aug. 10, 1948, KU 4557-63. *Saguache County:* 32 mi. W, 2 mi. N Saguache, 9800 ft., *Neotoma cinerea,* July 4, 1949, KU 4023-24, 4030-31, 4547-53. *San Juan County:* 6½ mi. SW Silverton, 9900-10,100 ft. *Neotoma cinerea,* KU 4606-19—*Zapus princeps,* KU 4565-4605; July 19, 1949. *La Plata County:* 8 mi. N, 1 mi. W Hesperus, 9500 ft., *Neotoma cinerea,* July 4, 1949, KU 4564. Pennsylvania—*Wayne County: Peromyscus maniculatus,* Aug. 1, 1946, KU 4620. Maine—*Hancock County:* Mt. Desert Island, *Peromyscus maniculatus,* Aug. 19, 1928, KU 4027.

Additional records. Brennan and Wharton (1950:171-172): Colorado—*Jackson County: Microtus pennsylvanicus modestus,* July 14, 1926, 1. *Conejos County: Neotoma* sp., Aug. 19, 1931, 5.

Trombicula (Neotrombicula) browni Brennan and Wharton

Figures 9 and 10. Tables 3-4, 8-9.

Trombicula (Neotrombicula) browni Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 178-179, type: USNM, no. 1840, Washakie Co., Wyo., 9 mi. E, 4 mi. N Ten Sleep, at 7000 ft., *Peromyscus maniculatus,* July 13, 1947. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 57.

Diagnosis. A member of the "microti" group with the larval characters as follows: seta on palpal femur and on genu nude; galeal setae usually single branched; first posthumeral row with ten to fourteen setae, more than 40 dorsal body setae; sensilla with few minute barbs.

Geographic range. Known only from the type locality in the Big Horn Mountains of northern Wyoming.

Seasonal occurrence. The only collections of this species were made in mid-July.

Remarks. At least one galeal seta was branched on each of the specimens examined. However, Brennan and Wharton (1950:178) reported that "no barbs could be detected" in one of the four specimens examined. Usually the galeal seta had a single branch, however, two or three branches sometimes occurred. On two specimens one of the galeal setae was nude.

The number of setae in the first posthumeral row varied from ten to fourteen. These were distributed as follows (included are the four specimens reported by Brennan and Wharton 1950:179): ten

setae present on two specimens, eleven on three, twelve on three, thirteen on two, and fourteen on one.

Specimens examined. Total number 10, as follows: WYOMING. *Washakie County:* 9 mi. E, 4 mi. S Ten Sleep, 7000 ft., *Microtus longicaudus,* KU 4101-04—*Peromyscus maniculatus,* KU 4105—*Tamiasciurus hudsonicus,* KU 4110—*Zapus hudsonius,* KU 4106-09, all collected July 13-17, 1947.

Comparison of *T. microti, T. harperi,* and *T. browni*

A comparison of *T. microti, T. harperi,* and *T. browni* specimens from Colorado, Wyoming, and northeastern Utah in the Snow Entomological Museum of the University of Kansas is presented in table 3. These specimens are listed in table 4.

The ten specimens of *T. browni* examined were readily separable from the other two species by the greatly reduced barbs on the sensilla and the larger number of dorsal and ventral setae.

T. microti and *T. harperi* apparently are separate sympatric species. The morphological differences are summarized in table 3. The seasonal occurrence of these two species on hosts in the Rocky Mountain region apparently differ; *harperi* has been collected in the late spring and summer (June 11 to August 20) while *microti* has been collected in the summer and early fall (July 19 to October 25). The numbers of larvae of *harperi* and *microti* collected from each county in Wyoming, northeastern Utah and Colorado differ as shown in table 4. It is interesting to note that no *microti* were collected in Washakie County, Wyoming and Boulder County, Colorado, while no *harperi* were collected from Summit County, Utah. The author, therefore, agrees with Brennan and Wharton (1950) in considering these as separate species since they seem to have different but broadly overlapping seasons of activity, and since nearly all of the 578 specimens studied are recognizably distinct.

Nonetheless, there are a few specimens which cannot be satisfactorily placed as to species. By using the presence or absence of branches on the galeal setae and the number of setae in the first posthumeral row, seven of the specimens examined which could not definitely be allocated either to *T. microti* or *T. harperi* are indicated as questionable in table 4; most of the seven specimens were from large series readily identifiable as *microti, harperi,* or a mixture. The county, state and slide number of these specimens are as follows: Carbon County, Wyoming, KU 4148; Rio Blanco County, Colorado, KU 4008, 4009, 4012; Boulder County, Colorado, KU 4134,

4415 (both are listed under *T. harperi*); Dolores County, Colorado, KU 4014. (This specimen, furthermore, has but a few barbs on the sensilla.)

TABLE 3

Comparison of *T. harperi*, *T. microti* and *T. browni* from the Rocky Mountain Region

	T. harperi	*T. microti*	*T. browni*
Galeal setae	Nude (occasionally one with single branch)	Branched (usually two or more branches)	Branched (usually with single branch)
Setae of first posthumeral row	8 or 9 (seldom 7, 10 or 11)	6 (occasionally 7)[1]	10 to 14
Sensillary barbs	Pronounced along entire length.	Pronounced along apical two-thirds.	Few and minute on basal half.
Parasubterminala	Usually branched.	Branched or unbranched.	Nude.
Body setae: dorsal	26 to 38 (mean 29) (28 specimens)	27 to 34 (mean 30) (11 specimens)	47 to 62 (mean 54) (7 specimens)
ventral	26 to 42 (mean 34) (28 specimens)	34 to 48 (mean 41) (11 specimens)	51 to 68 (mean 60) (6 specimens)
Total	54 to 78	67 to 79	107 to 125
Collected	June to August.	July to October.	July.

1. The type series of *T. parkeri* Radford, reputedly a synonym of *microti*, has from 6 to 11 setae in the first posthumeral row (Brennan and Wharton, 1950).

Trombicula (*Neotrombicula*) *loomisi* sp. nov.*

Figures 7 and 8. Table 8.

Diagnosis. A member of the "microti" group with the following larval characters: all setae of the first four palpal segments feathered; galeal seta branched; several pronounced apical branches on the sensilla.

Body. Slightly engorged specimen, length 140 μ, width 99 μ. Eyes two on each side, subequal. Color in life deep red.

Gnathosoma. Palpal coxa with feathered seta; femur with dorsal feathered seta; one genu with dorsal feathered seta, the other genu with two feathered setae, one dorsal, the other lateral (five paratypes with a single dorsal feathered seta on each genu, one speci-

* The species is named for Mr. Richard B. Loomis who collected the type material.

TABLE 4

Neotrombicula examined from Wyoming, northeastern Utah, and Colorado

Locality and date	Total	Question[4]	microti	harperi	browni	subsignata	finleyi	autumnalis
Washakie County, Wyo. July 13–18, 1947	79			69	10			
Carbon County, Wyo. July 23–25, 1947	117	1	12	103		1		
Summit County, Utah August 2, 1951	69		69					
Rio Blanco County, Colo. July 27–29, 1947	87	3	6	78				
Boulder County, Colo. July 31–August 8, 1947	156	2		148		6		
Douglas County, Colo. August 4, 1948	6			6				
Gunnison County, Colo. August 10, 1948	12		5	7				
Dolores County, Colo. October 18, 1949	5	1					2	2
San Juan County, Colo. July 19, 1949	56		1	55				
Saguache County, Colo. July 31, 1948	11			11				
La Plata County, Colo. July 4, 1949	1			1				

4. Questionable specimens are probably either *T. microti* or *T. harperi*.

men, KU 5805, with two setae on one genu as holotype); tibia with dorsal, lateral, and ventral setae, all feathered; tarsus with spur, subterminala, one robust dorsal feathered and six ventral feathered setae. One galeal seta with two branches, the other with three branches (paratypes with one to four branches).

Legs. Leg I: coxa, trochanter, basifemur each with one feathered seta; telofemur with five feathered setae; genu with two genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala and nine feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately 21 feathered setae. Leg II: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with four feathered setae; genu with genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately 15 feathered setae. Leg III: coxa with seta missing on holotype but base present (paratypes with one feathered seta); trochanter with feathered seta; basifemur with two feathered setae; telofemur with mastifemorala and two feathered setae; genu with genuala and three feathered setae; tibia with tibiala, mastitibiala, and five feathered setae; tarsus with two mastitarsalae and approximately 12 feathered setae.

Scutum. Broadly rounded posteriorly (posterior angle of four paratypes tends to be flattened); large and few punctae. Sensillary bases posterior to bases of the posterolateral setae. One sensilla with four apical branches, the other with three (paratypes with three to five apical branches); few minute basal barbs present. Scutal measurements as follows in microns: AW, 69; PW, 94; SB, 28; ASB, 33; PSB, 21; AP, 29; AM, 46; AL, 46; PL, 59; S, 94 (see table 8 for means and the extremes of types).

Setae. Dorsal setal formula, 2-6-6-4-6-4; ventral setae 2-2-32 (one paratype, KU 5806, with three humeral setae); total body setae 64. Dorsal body setal measurements as follows in microns: humeral seta, 55; median seta of first posthumeral row, 54; posterior seta, 45.

Type material. Holotype (slide no. KU 5803) and two paratypes (KU 5801-02) from *Reithrodontomys megalotis* (field no. RL521102-3), one paratype (KU 5804) from *Peromyscus maniculatus* (RL521102-4), and two paratypes (KU 5805-06) from *Mus musculus* (RL521102-6), all from Yuma County, Colorado, 1 mile east of Laird, at the edge of the North Fork of the Republican River, collected November 2, 1952; one paratype (KU 5807) from *Peromyscus maniculatus* (RL521101-8), from Dundy County, Nebraska,

5 miles north, 2 miles west of Parks, Rock Creek State Fish Hatchery, collected November 1, 1952; all hosts collected by Richard B. Loomis and J. Knox Jones, Jr. The holotype, and four paratypes have been deposited in the University of Kansas Snow Entomological Museum. One paratype each will be sent to the United States National Museum and The Rocky Mountain Laboratory.

Remarks. In the key of Brennan and Wharton (1950) *T. loomisi* would key out to *T. jewetti;* however, it differs from the latter in having the apparently unique condition of three to five pronounced apical branches and a few minute basal barbs on the sensilla (figure 7). A comparison of scutal measurements of *jewetti* (Brennan and Wharton, 1950:182) and *loomisi* indicates a difference in the ratio of the PL to the AL; six specimens of *loomisi* had an average of .85μ (.78 to .94), while among five *jewetti* the average was .72μ (.66 to .76).

Ecology. The specimen of *T. loomisi* from Dundy County, Nebraska, was taken from a *Peromyscus maniculatus,* at the base of a woodrat nest, in the same general area as the hosts of *T. autumnalis* and *T. whartoni.* However, *loomisi* was in a dry situation while the latter two were found in a marshy habitat. The *loomisi* from Yuma County, Colorado, were taken from hosts trapped in a meadow at the edge of the North Fork of the Republican River which had flowing water present despite the drouth throughout the Great Plains at that time. The soil here was predominantly sandy with a good stand of grass.

The larvae, all unengorged or only slightly engorged, were recovered by washing the mammals in water and detergent. Preliminary examinations revealed only a single unattached larva crawling on the outer hairs of one ear. The rarity (only five larvae from 14 hosts examined from the Colorado locality) and the relatively unengorged condition indicates that these larvae had just appeared (November 1-2) and strongly suggests that this is a late fall and winter chigger.

Trombicula (*Neotrombicula*) *finleyi* sp. nov.*

Figures 11-15, Tables 4 and 8.

Diagnosis. A member of the "microti" group with the following larval characters: palpal femur and genu each with branched seta; galeal seta branched; sensilla with pronounced barbs along most of its length; ratio of the PL to the AL .9.

* The species is named for Mr. Robert B. Finley, Jr., who collected the type material.

Body. Engorged specimen, length 200 μ, width 145 μ. Eyes two on each side, subequal.

Gnathosoma. Palpal coxa with feathered seta; femur and genu each with single dorsal branched seta; tibia with dorsal branched seta, lateral seta of one tibia branched, the other obscure (paratype with both lateral setae nude), and ventral feathered seta; tarsus with setae obscure (paratype with spur, subterminala, single robust dorsal feathered and six ventral feathered setae). One galeal seta with two branches, the other seta obscure (paratype with one seta branched, the other nude).

Legs. Leg I: coxa, trochanter, basifemur each with one feathered seta; telofemur with five feathered setae; genu with two genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala, and nine feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately 19 feathered setae. Leg II: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with four feathered setae; genu with genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately 15 feathered setae. Leg III: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with mastifemorala and two feathered setae; genu with genuala and three feathered setae; tibia with tibiala, mastitibiala, and five feathered setae; tarsus with two mastitarsalae and approximately ten feathered setae.

Scutum. Posterior angle rounded; moderately heavy and numerous punctae evenly distributed. Sensillary bases slightly anterior to the bases of the anterolateral setae. Sensilla with pronounced barbs along most of its length. Scutal measurements of holotype as follows in microns: AW, 69; PW, 89; SB, 28; ASB, 30; PSB, 27; AP, 29; AM, 41; AL, 46; PL, 50; S, 90. (See table 8 for measurements of paratype.)

Setae. Dorsal setal formula 2-7-7-4-6-3-2, (paratype, 2-6-4-6+12); ventral setae 2-2-35, (paratype, 2-2-38); total body setae 70, (paratype, 72). Dorsal setal measurements as follows in microns: humeral seta 48, median seta of the first posthumeral row 41, posterior seta 44.

Type material. Holotype (slide no. KU 4001) and paratype (KU 4002) taken from *Neotoma cinerea orolestes* (field no. RBF 491018-1), Dolores County, Colorado, ten miles east, fifteen miles

north of Dolores, 8250 ft., October 18, 1949, by Robert B. Finley, Jr.; in the Snow Entomological Museum of the University of Kansas.

Remarks. *T. finleyi* apparently is closely related to *T. lipovskyi;* however, the former has a branched galeal seta, a different scutal shape, and the means of the PL to the AL in the former is .91 to .92 while that of the latter is .68 to .71. Also *finleyi* has the ASB scutal measurement smaller in relation to the rest of the scutum than in *lipovskyi* (compare fig. 11 with 16 and 23, see table 9). The only locality known for *finleyi* is on the western slope of the Rocky Mountains, while *lipovskyi* has been taken in the Great Plains as far west as northwestern Kansas, approximately 300 miles to the northeast.

In the key of Brennan and Wharton (1950:162), *finleyi* would run to *jewetti* from which it differs in having the sensilla with pronounced barbs along most of its length. The ratio of the PL to AL among five *jewetti* is .66 to .76.

Ecology. *T. finleyi* was collected from the same individual host as *T. autumnalis* (see the latter for an account of the locality).

Trombicula (*Neotrombicula*) *richmondi* Brennan and Wharton

Table 8.

Trombicula (*Neotrombicula*). *richmondi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, p. 183, type: Somerset Co., Pa., *Microtus pennsylvanicus,* Oct. 16, 1947, Carnegie Museum, Pittsburgh. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

Diagnosis. A member of the "microti" group with the larval characters as follows: first four palpal segments with all setae feathered; leg I with a single genuala.

Geographic range. This species is known from Arkansas (Polk County) and western Pennsylvania (Brennan and Wharton, 1950: 183).

Seasonal occurrence. In Pennsylvania this species has been taken as early as September 27, and as late as April 8 according to Brennan and Wharton (1950:183); in Arkansas the only record was March 29.

Remarks. The specimen examined from Arkansas has approximately 60 dorsal and 52 ventral setae while one examined from Pennsylvania has approximately 28 dorsal and 40 ventral setae. There were no other significant differences between the two specimens examined.

Specimens examined. Total number 2, as follows: ARKANSAS—*Polk County:* 2 mi. N Wicks, *Peromyscus leucopus,* Mar. 29, 1948,

KU 4005. Pennsylvania—*Westmoreland County:* 2 mi. SSE Rector, *Clethrionomys gapperi,* Feb. 27, 1947, KU 4017.

Trombicula (*Neotrombicula*) *lipovskyi* Brennan and Wharton

Figures 1, 16-18, 23. Tables 5, 7-9.

Trombicula (*Neotrombicula*) *lipovskyi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, p. 177, type: USNM no. 1838, Norton Co., Kans., 4 mi. W, 1 mi. S Logan, *Peromyscus maniculatus,* Oct. 25, 1946. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

Diagnosis. A member of the "microti" group with the larval characters as follows: all setae on first four palpal segments branched or feathered; galeal seta nude; sensilla with pronounced barbs; scutum broadly rounded posteriorly and with numerous minute punctae.

Geographic range. This species is known from Kansas (Norton County) southeastern Nebraska (Richardson County) east to Missouri (Pike and Stoddard counties), southward to Arkansas (Polk County) and Oklahoma (McClain County).

Seasonal occurrence. This species has been taken as early as October 7 (Leavenworth County, Kansas), and as late as April 27 (Douglas and Russell counties, Kansas).

Remarks. The measurements of the posterolateral setae (PL) (Table 9) and the number of barbs on the sensilla (figs. 16, 23) indicate a northwest-southeast cline. The number of barbs on the sensilla of specimens examined from each area were as follows: nine specimens from Norton County, Kansas, had 15 to 22 barbs (mean 19); nine from Douglas County, Kansas, 8 to 17 barbs (mean 14); ten from Cleveland and McClain counties, Oklahoma, 12 to 20 barbs (mean 16); 10 from Washington County, Arkansas, 9 to 20 barbs (mean 12); 20 from Polk County, Arkansas, 5 to 17 barbs (mean 11).

The body setal counts of 24 specimens from the above five areas were as follows: the dorsal setal count was 30 to 46 (mean 35); the ventral setal count was 34 to 51 (mean 40); and the total body setae were 68 to 86 (mean 76).

Two specimens examined from Norton County, Kansas, (KU 4948, 4967) had both galeal setae with a single branch.

Habitat. T. lipovskyi is the most abundant *Neotrombicula* throughout central and eastern Kansas. In northeastern Kansas, particularly Douglas County, where intensive studies have been conducted, this species is known to occur in grassland as well as woodland habitats, as shown by the host data and by chigger

sampling. The six individuals collected on chigger samplers were from the wooded Plot A near the quarry, at the University of Kansas Natural History Reservation (see discussion under *T. sylvilagi*). In other parts of Kansas where collections have been made, the areas were essentially grassland with few or no trees present.

In Arkansas (Washington and Polk counties) *T. lipovskyi* was found on *Sylvilagus floridanus* taken in forest habitats.

Hosts. In northeastern Kansas, the most important host of *T. lipovskyi* seems to be *Sylvilagus floridanus* while other important hosts include *Neotoma floridana, Sigmodon hispidus, Microtus ochrogaster,* and *Sciurus niger* in the order of probable importance as hosts. Birds are only minor hosts for this chigger.

The main site of attachment of *lipovskyi* on most of the host species examined appears to be within the ears; however considerable numbers may be found on other parts of the body.

One *Sciurus niger* collected in Douglas County, Kansas had 30 of 50 *lipovskyi* attached just below the ears while none was found within the ears; the other 20 chiggers were from other parts of the body.

Several *Sylvilagus floridanus* collected in Douglas County, Kansas were brought into the laboratory, skinned and divided up into the following divisions: ears, head, feet, the anal and tail region, and the remaining parts of the body. These five portions were washed separately. Two rabbits collected in late November yielded the following combined total of *lipovskyi:* ears, 129; head, 55; feet, 110; anal and tail region, 31; and body, 41. The examination of rabbits during November revealed small pockets of chiggers attached between the toes. It appears that on *Sylvilagus,* the major concentrations of *lipovskyi* are within the ears and on the feet.

Several *Neotoma floridana* nests as well as one unidentified rodent nest (probably *Peromyscus*) were collected in Douglas County, Kansas, in November and December during the height of the *T. lipovskyi* season. They were placed individually into modified Berlese funnels and the residue from the *Neotoma* nests yielded three unengorged and four fully engorged *lipovskyi* larvae, while the unidentified rodent nest yielded one unengorged and three fully engorged *lipovskyi* larvae. Material obtained in the same way from a *Neotoma floridana* nest taken in McClain County, Oklahoma during January, 1952, yielded two fully engorged larvae. This indicates that at least some of the fully engorged *lipovskyi* larvae fall from the

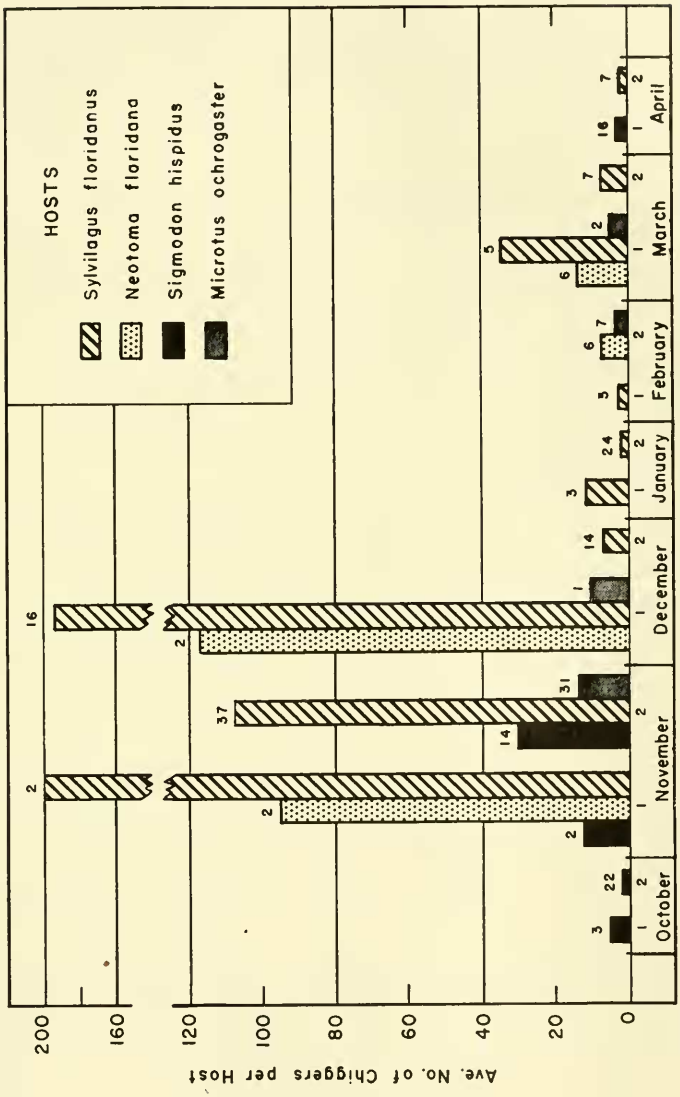

FIG. 1. The total number of larval *T. lipovskyi* recovered per host examined, in each one-half month period from 1947 to 1952 in northeastern Kansas. The number above each bar is the total number of hosts examined during that period.

hosts in the nests and that unengorged larvae are also present in the nests.

Seasonal abundance. Northeastern Kansas and central Oklahoma: In northeastern Kansas the earliest larval record of *T. lipovskyi* is from *Sylvilagus floridanus* taken on Oct. 7, 1946, according to Brennan and Wharton, (1950:177). The earliest record during the period studied, from 1947 to 1952, is October 15, 1948, from *Sigmodon hispidus.* The number of larvae upon the hosts during this period (fig. 1) increased rapidly from the few in October to a peak lasting from the second week in November to mid-December, followed by a sharp decline late in December, lasting through January and February, probably due to the cold weather. In late February and early March, there seems to have been a second, but much smaller increase in larval occurrence on hosts, probably due to the warmer weather. Following this was the decline and disappearance of all larvae by the last of April (last record, April 27, 1952, from *Sylvilagus floridanus*).

The seasonal abundance of *T. lipovskyi* on hosts from McClain and Cleveland counties, Oklahoma (Fall, 1951 to Spring, 1952), appeared similar to that found in northeastern Kansas.

Figure 1 presents a summary of the seasonal abundance, from 1947 to 1952, of *T. lipovskyi* in northeastern Kansas from the four most important hosts, *Sylvilagus floridanus, Neotoma floridana, Sigmodon hispidus, and Microtus ochrogaster,* based on one-half month periods.

Post-larval development. The required period for the development of *T. lipovskyi* in culture tubes from the engorged larva to the adult was approximately 75 days under laboratory conditions and approximately 300 days outdoors (which included over wintering) as shown in table 5. The culture tubes were 5 dram plastic-stoppered opticlear vials lined with a mixture of hardened plaster-of-Paris and charcoal as described by Lipovsky (1953a). These were kept at the proper humidity by adding water. The nymphs were fed the eggs of *Sinella curviseta* Brook (Entomobryidae, Collembola) as recommended by Lipovsky (1951a). Several of these culture tubes containing approximately 40 fully engorged larvae were kept at room temperature (75°-85° F.) in the laboratory; one culture tube was placed in the refrigerator (39°-42° F.); and one tube was placed outdoors in the soil (November 27, 1951, to July 29, 1952).

The culture tubes in the laboratory were examined every two or

three days, with less frequent examinations of the outdoor and refrigerator tubes.

The outdoor culture tube was placed in a vertical position, two to three inches below the soil surface, which was devoid of vegetation, adjacent to the southwest corner of a building. The soil temperature was recorded as low as 28° F. in December and as high as 92° F. in July.

The duration of the larval stage indicated in table 6 includes the period from the placement of the engorged larvae in the culture tube until they ceased to move their legs. The prenymphal stage (nymphochrysalis or protonymph of some authors), which follows the larval stage, is here divided into two parts: the first being the part of the prenymphal stage which lasts from the time the larval chiggers cease to move until the cuticle starts to split; and secondly, the rest of the prenymphal stage. In order to determine when the larvae have ceased to move and have passed into the first part of the prenymphal stage (not merely inactivity because of the colder temperatures), the outdoor and refrigerator culture tubes were placed in the warm laboratory (temperature 70°-85° F.) for approximately 15 minutes. When first removed from the colder temperatures, usually all of the chiggers were inactive; however, upon warming at the laboratory temperatures, those still in the larval stage became active. When removed from the refrigerator, the larvae were always inactive.

Individuals of *T. lipovskyi* remained as larvae for a considerably longer period at the colder temperatures (62 days outdoors, 72 days in refrigerator) than in the laboratory (6 days).

Those chiggers kept in the refrigerator did not enter the second part of the prenymphal stage until they were removed from the cold temperature (approximately eight to nine months after they entered the first part of the prenymphal stage). However, once transferred to the warmer laboratory, it took only six days for the majority of these chiggers to begin the second part of the prenymphal development; this compares to 19 days for those kept constantly in the laboratory; the difference suggests that some development occurred during the eight to nine months period at 39°-42° F.

The second part of the prenymphal stage did not appear in the outdoor culture tube until the relatively warmer month of March (following the colder months of January and February). The adult stages first appeared during the last half of June, eight months after

the engorged larvae were placed in the culture tube. It appears, therefore, that the larval and the first part of the prenymphal stages overwinter. Furthermore, there seems to be only a single generation of *lipovskyi* per year.

TABLE 5

Post-larval Development of *T. lipovskyi*

Cultures		Lab. 70–85°F.	Refrigerator		Culture tube in soil (outdoors) (Nov. 27 to July 29, 1952)	
			39–42°F.	Lab.	No. days	Months
Larva	range[5] median[6] number[7]	2–9 6 (23)	28–81 76 (8)		10–82 62 (20)	Nov. 27 to last half of Feb. (overwinter)
Pre-nymph first part	range median number	11–21 19 (21)	230–283	6–8 6 (7)	129–165 132 (19)	Nov. 29 to first half of April (overwinter)
Pre-nymph second part	range median number	10–22 13 (20)	....	10 ..... (5)	32–40 36 (14)	Last half of March to last half of April.
Nymph	range median number	15–30 ..... (9)	....	44 ..... (1)	49–81 51 (3)	Last half of April to first half of July.
Pre-adult	range median number	15–18 ..... (4)	....	17 ..... (1)	12–18 13 (3)	Last half of June to last half of July.
Adult	number pres.	(4)	.....	(1)	(3)	Appeared the last half of June until last of July.

5. The range in days that individuals remain in each stage.
6. The number of days before 51 percent of the individuals transform to the next stage.
7. The number of individuals surviving each stage and passing into the next stage.

Specimens examined. Total number 950, all in the University of Kansas collection, as follows: NEBRASKA—*Richardson County:* 4-6 mi. W Falls City, *Microtus ochrogaster,* Nov. 30, 1947, KU 4995, 5038, 5109-11, 5203-20. KANSAS—*Norton County:* 3-5 mi. W, 1 mi. S Logan, 85 specimens, all topotypes, *Peromyscus maniculatus,* KU 4948-56, 4965-85—*Reithrodontomys megalotis,* KU 4957-64; —*Sylvilagus floridanus,* KU 4901-47, all collected Oct. 23-30, 1947. *Russell County:* 5 mi. N, 2 mi. E Gorham; *Peromyscus maniculatus,* KU 5694; 7½-9 mi. S Russell, *Peromyscus maniculatus,* KU 5685-93; 5 mi. S Waldo, *Sylvilagus floridanus,* KU 5684; all collected April

26, 1952. *Nemaha County:* 2½ mi. S Sabetha, *Blarina brevicauda,* KU 5094-5105—*Microtus ochrogaster,* KU 5087-93—*Reithrodontomys megalotis,* KU 5106-08, all collected Nov. 30, 1947. *Brown County:* 3 mi. N Hiawatha, *Microtus ochrogaster,* KU 4996-97, 5039, 5074-75, 5080-86—*Peromyscus maniculatus,* KU 5076; 7 mi. N, up to ½ mi. E Hiawatha, *Microtus ochrogaster,* KU 5079—*Rattus norvegicus,* KU 5077; 5 mi. S Hiawatha, *Microtus ochrogaster,* KU 5041-43, 5078—*Mus musculus,* KU 5070-73—*Sigmodon hispidus,* KU 5040; Near Reserve, *Mus musculus,* KU 5112-24, all collected Nov. 29-30, 1947. *Jefferson County:* 5½ mi. N, ½ mi. E Lawrence, *Asio otus,* Nov. 24, 1952, KU 5626-27—*Peromyscus leucopus,* Jan. 29 and Feb. 19, 1952, KU 5667-68, 5670-71—*Richmondena cardinalis,* Jan. 26, 1952, KU 5665—*Sciurus niger,* Nov. 21, 1951, KU 5602-11—*Sylvilagus floridanus,* Nov. 21-24, 1951, KU 5597-5601, 5622-25, March 15, 1952, KU 5673-77; 6 mi. E Perry, *Neotoma floridana,* KU 5264-65—*Parus atricapillus,* KU 5876-77, both collected Dec. 28, 1948; 7 mi. E, ½-3½ mi. N Valley Falls, *Didelphis marsupialis,* KU 5127—*Sylvilagus floridanus,* KU 5125-26, both collected Nov. 30, 1947. *Douglas County:* 2 mi. W, 1 mi. N Baldwin, *Sylvilagus floridanus,* Nov. 30 and Dec. 4, 1951, 19. Univ. Kans. Nat. Hist. Res., 4-5 mi. N, 1½ mi. E Lawrence, and vicinity, *Centurus carolinus,* Nov. 27, 1948, 1—*Microtus ochrogaster,* Dec. 9, 1948, 1, Nov. 23 and 29, 1951, 5, April 18, 1952, 5—*Neotoma floridana,* Dec. 9, 1948, 13, Nov. 2, 1946, 3, Dec. 6, 1947, 13, Nov. 15, 1952, 11—*Neotoma floridana* nest, Dec. 5, 1948, 2, Dec. 9, 1948, 4—*Peromyscus leucopus,* Feb. 8, 1948, 3—*Peromyscus maniculatus,* Nov. 23, 1951, 1—*Reithrodontomys megalotis,* Nov. 19-29, 1951, 6, Jan. 9, 1952, 1, Feb. 1, 1952, 1—Rodent (probably *Peromyscus*) nest, Nov. 6, 1948, 4—*Sigmodon hispidus,* Nov. 23, 1951, 6—*Sylvilagus floridanus,* Nov. 30, 1948, 10—chigger samplers, Oct. 28, 1951, 1, Nov. 9, 1951, 1, Jan. 14, 1952, 4; 6 mi. W Lawrence, *Sciurus niger,* 12; 2-4 mi. W Lawrence, *Microtus ochrogaster,* March 6, 1949, 1—*Neotoma floridana,* March 30, 1949, 2, Nov. 12, 1949, 17—*Microtus (Pitymys) pinetorum,* Nov. 29, 1951, 2, Jan. 26, 1952, 1, Feb. 8, 1952, 1—*Neotoma floridana* nest, Nov. 12, 1949, 3—*Sylvilagus floridanus,* March 3-7, 1949, 18, Nov. 12, 1949, 18; Lawrence and vicinity, *Melospiza melodia,* Nov. 25, 1947, 1—*Reithrodontomys megalotis,* Dec. 16, 1948, 3—*Richmondena cardinalis,* Dec. 16 and 28, 1948, 2—*Sigmodon hispidus,* Nov. 3, 1947, 21, Oct. 15, 1948, 17, Nov. 18, 1948, 2—*Sturnella neglecta,* Nov. 5, 1947, 1—*Sylvilagus floridanus,* Nov. 12, 1947, 15, Dec. 16 and 31, 1948, 18, Nov. 28, 1951, 5; 3 mi. S,

1 mi. E Lawrence, Haskell bottoms, *Microtus ochrogaster*, April 8, 1947, 2—*Sigmodon hispidus*, Oct. 25, 1947, 1; 1 mi. W, 3 mi. S Pleasant Grove, *Sylvilagus floridanus*, Dec. 4, 1948, 46, Dec. 29, 1948, 26, Jan. 29, 1949, 8, March 3, 1949, 10, April 21, 1949, 2, Jan. 12, 1952, 4; 4½ mi. S Pleasant Grove, *Sylvilagus floridanus*, April 27, 1952, KU 5683; 3 mi. S Lone Star Lake, *Sylvilagus floridanus*, April 23, 1949, 1; Near Stull, *Canis latrans*, Dec. 14, 1947, 3—*Lepus californicus*, Dec. 14, 1947, 6—*Sylvilagus floridanus*, Dec. 14, 1947, 16, Jan. 2 and 9, 1949, 20, Feb. 7 and 14, 1949, 3; 2 mi. S Worden, *Sciurus carolinensis*, Nov. 26, 1949, 11—*Sciurus niger*, Nov. 26, 1949, 30, Jan. 19, 1950, 3. *Anderson County:* Welda, *Sylvilagus floridanus*, KU 5056-69. *Barber County:* 3½ mi. S, 1 mi. W Aetna, *Neotoma micropus*, KU 5440-48; 5 mi. S Sun City, *Peromyscus* sp. KU 5442-44, both collected April 11 and 12, 1949.

OKLAHOMA—*Cleveland County:* 5 mi. SW Okla. Univ., Norman, *Sylvilagus floridanus*, Feb. 23, 1952, KU 5582; 3 mi. SW Norman, *Sylvilagus floridanus*, Nov. 21, 1951, KU 5548-66; 5 mi. S Norman, *Neotoma floridana*, Dec. 5, 1951, KU 5567-78; 10 mi. SE Norman, *Sigmodon hispidus*, Dec. 28, 1949, KU 5721-42. *McClain County:* 8 mi. SW, 8 mi. W Norman, *Neotoma floridana*, March 14, 1952, KU 5583-85, April 14, 1952, KU 5586-87—*Neotoma floridana* nest, Jan., 1952, KU 5580-81. ARKANSAS—*Washington County:* 2 mi. S Winslow, *Sylvilagus floridanus*, March 29, 1948, KU 5449-84. *Polk County:* 5 mi. W Mena, Rich Mt., *Sylvilagus floridanus*, March 2, 1951, KU 5485-5546, 5702-04.

Additional records. Brennan and Wharton (1950:177): KANSAS—*Leavenworth County: Sylvilagus floridanus*, Oct. 7, 1946, 3. OKLAHOMA—*Latimer County: Neotoma floridana*, March 17, 1929, 1. MISSOURI—All from *Sylvilagus floridanus*, Jan. 15-28, 1943, counties and number of specimens as follows: *Caldwell*, 2; *Howard*, 1; *Pike*, 2; *Johnson*, 1; *Pettis*, 1; *Laclede*, 2; *Jasper*, 2; *Stoddard*, 7.

Trombicula (*Neotrombicula*) *whartoni* Ewing

Figures 19-22. Tables 6-9.

Trombicula whartoni Ewing, 1929, Ent. News, vol. 40, no. 9, p. 296, Nov., type USNM no. 999, Summerville, S. C., from a bird; 1931, Proc. U. S. Nat. Mus. 80, Art. 8, p. 10. Radford, 1942, Parasitology, vol. 34, p. 57. MacCreary, 1945, Jour. Econ. Ent., vol. 38, p. 127. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Thor and Willmann, 1947, Das Tierreich, Lief. 71 b, p. 269. Philip and Fuller, 1950, Parasitology, vol. 40, no. 1-2, p. 56.

Trombicula (*Neotrombicula*) *whartoni*, Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 175-176. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

Trombicula rohweri Ewing, 1942, Jour. Parasit., vol. 28, no. 6, p. 488, type: USNM no. 1413, from *Troglodytes aedon,* Harrison Co., Miss., Handsboro, Feb. 14, 1940, coll. G. G. Rohwer, Bish. no. 29458, lot 40-3701. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Philip and Fuller, 1950, Parasitology, vol. 40, no. 1-2, p. 56.

Trombicula (*Neotrombicula*) *rohweri,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 174-175. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

Diagnosis. A member of the "microti" group with the larval characters as follows: all setae on first four palpal segments branched or feathered; galeal seta nude; sensilla with minute to pronounced basal barbs, rarely nude; scutum angular posteriorly and with few large punctae (Arkansas specimens with the punctae somewhat smaller and more numerous).

Geographic range. This species is known from southwestern Nebraska (Dundy County), Kansas (Nemaha to Miami counties), Illinois (Champaign County), and Pennsylvania (Dauphin County, south to Florida (Orange County), Mississippi (Harrison to Franklin counties), and northwestward to Arkansas (Miller to Polk counties) and Oklahoma (McCurtain and Adair counties).

Seasonal occurrence. In Kansas, Nebraska, and Missouri, this species has been taken as early as October 12 (Miami County, Kansas) and as late as January 28 (Pemiscot County, Missouri). In Arkansas (Polk County), this species has been collected from March 3 to 29.

Remarks. Examination of the lectotype and the three cotypes (USNM no. 1413) of *T. rohweri* revealed that all critical characters are consistent with *whartoni.* Brennan and Wharton (1950:175) stated that, "*T. rohweri* is very close to *T. whartoni* from which it is separated by the entirely nude sensillae. However, since both forms occur in the same locality they probably represent two species." However, on careful examination of the four types (USNM no. 1413) with a phase contrast microscope it was found that although most of the barbs were broken off, distinct stumps were present. The number and size of these stumps as well as the few remaining barbs indicate that the barbs are similar to the more pronounced condition found in the Arkansas *whartoni.*

A single specimen from Jasper County, Missouri, listed as *T. rohweri* by Brennan and Wharton (1950:175) was examined and the sensillae were found to be nude. This certainly represents an extreme of *T. whartoni* rather than a separate species, since other specimens within the geographic range of *whartoni* were also found to possess nude sensillae.

The number of barbs on the sensillae of specimens from four areas are as follows: four specimens from Dundy County, Nebraska, with three to five barbs (mean four); 20 from Douglas County, Kansas, with zero to five barbs (mean two); ten from Polk County, Arkansas, with seven to twelve barbs (mean nine); seven from Orange County, North Carolina, with four to seven barbs (mean five) (figs. 19-22).

The specimens from Arkansas and also those from Oklahoma further differ from those examined from Kansas, Nebraska, and North Carolina in having longer barbs on the sensilla, a greater number of punctae on the scutum, and in the shape of the scutum (fig. 22). The characters somewhat approach those of *T. lipovskyi* in Arkansas.

The punctae on the scutum of the North Carolina specimens examined are slightly fewer in number and larger than those from Kansas, Nebraska, and Arkansas.

The posterolateral setal measurements (tables 8 and 9) varied only slightly between the areas studied.

The body setal counts of 16 specimens from the four areas are as follows: the total dorsal setal count was 30 to 43 (mean 35); ventral setal count was 33 to 50 (mean 41); total body (dorsal and ventral) setae 63 to 89 (mean 76).

Habitat. In northeastern Kansas, particularly Douglas County, where intensive collecting has been conducted, this species has been found on hosts in deciduous oak-hickory woodland and woodland edge habitats.

The specimens from Polk and Miller counties, Arkansas were taken from hosts in meadow habitats in oak-pine forest areas according to the collectors, Richard B. Loomis and Leonard M. Koger.

The *whartoni* from the Dundy County, Nebraska were taken with *autumnalis* (see habitat notes under the latter). While few trees (small willows), were present, the meadow habitat was marshy.

The specimens from Orange County, North Carolina were taken from Duke Forest.

This species probably cannot withstand the generally drier and colder conditions of the grasslands of the Great Plains and is, therefore, limited to the relatively moist woodlands to the east. When present in the Great Plains it seems to be restricted to woodlands and marshy habitats.

Hosts. The most important hosts of *T. whartoni* in northeastern Kansas apparently are *Sciurus niger* and *Sylvilagus floridanus* (see Table 6). Birds are also of some importance as hosts in this area.

Table 6

Trombicula (Neotrombicula) whartoni

collected in northeastern Kansas

Host	*No. examined* [8]	*No. with whartoni*	*Total no. whartoni*
Sciurus niger	12	6	42
Sciurus carolinensis	1	1	6
Sylvilagus floridanus	56	3	69
Mus musculus	30	2	3
Parus bicolor	2	2	5
Richmondena cardinalis	9	3	5
Junco hyemalis	12	3	4
Zonotrichia querula	6	1	1

Specimens examined. Total number 101 as follows: NEBRASKA—*Dundy County:* 5 mi. N, 2 mi. W Parks, Rock Creek State Fish Hatchery, *Microtus ochrogaster,* KU 4893-94—*Microtus pennsylvanicus,* KU 4891-92, both collected Nov. 1, 1952. KANSAS—*Nemaha County:* 2½ mi. S Sabetha, *Mus musculus,* Nov. 30, 1947, KU 4826. *Brown County:* 5 mi. S Hiawatha, *Mus musculus,* KU 4824-25; 1 mi. N Horton, *Richmondena cardinalis,* KU 4817-18, all collected Nov. 29, 1947. *Jefferson County:* 2 mi. NE Perry, *Junco hyemalis,* Oct. 26, 1948, KU 4829-31. *Douglas County:* K. U. Nat. Hist. Res., *Junco hyemalis,* Nov. 9, 1947, KU 4813-16; 7 mi. NW Lawrence, *Sciurus niger,* Nov. 11, 1949, KU 4835-38; 6 mi. W Lawrence, *Sciurus niger,* Nov. 29, 1947, KU 4819-23; 1 mi. W KU campus, Lawrence, *Sylvilagus floridanus,* Dec. 16, 1948, KU 4832-34; 4 mi. S Lawrence, *Parus bicolor,* KU 4808-10—*Richmondena cardinalis,* KU 4812, both collected Nov. 4, 1947; 2 mi. S Worden, *Sciurus niger,* KU 4841-58—*Sciurus carolinensis,* KU 4839-40—*Zonotrichia querula,* KU 4859, all collected Nov. 26-28, 1949; 2 mi. W 1 mi. N Baldwin, *Richmondena cardinalis,* Nov. 4, 1951, KU 4884-85—*Sylvilagus floridanus,* Nov. 30, 1951, KU 4876-83; 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951, KU 4872-75. *Miami County:* 3 mi. E, 1 mi. S Fontana, *Sciurus niger* and *carolinensis,* mixed skins, Oct. 12, 1948, KU 4890. MISSOURI—*Jasper County:* Rabbit, *Sylvilagus* sp., Jan. 24, 1947, Rocky Mt. Lab. no. AP 24274 (listed as *T. rohweri* by Brennan and Wharton, 1950:175). OKLAHOMA—*Adair County:* 1½ mi. E Stilwell, *Sigmodon hispidus,* KU 4896—*Reithrodontomys fulvescens,* KU 4897-8—*Peromyscus mani-*

8. Includes only those hosts examined during the known *whartoni* season (mid-October to mid-December) in this area.

culatus, KU 4899-4900, 5879, March 9, 1951. *McCurtain County:* 7 mi. N, 3 mi. E Broken Bow, *Neotoma floridana,* KU 5880, March 27, 1951. ARKANSAS—*Polk County:* 2 mi. NE Mena, along US Highway 71, *Peromyscus maniculatus,* KU 4860—*Reithrodontomys fulvescens,* KU 4862-64—*Mus musculus,* KU 4860-61—*Sigmodon hispidus,* KU 4895, all collected March 3, 1951; 2 mi. N Wicks, *Peromyscus leucopus,* Mar. 29, 1948, KU 4828. *Miller County:* 4 mi. N Texarkana, *Reithrodontomys fulvescens,* Mar. 28, 1948, KU 4827. MISSISSIPPI—*Harrison County:* Handsboro, *Troglodytes aedon,* Feb. 14, 1940, USNM No. 1413 (lectotype and three cotypes of *T. rohweri*). NORTH CAROLINA—*Orange County:* Duke Forest, New Hope Creek Division, Nov. 30, 1947, KU 4801-07.

Additional records. Brennan and Wharton (1950:174-177): KANSAS—*Douglas County: Cyanocitta cristata,* 1 specimen, and *Zonotrichia albicollis,* 1, collected Oct. 20, 1946. MISSOURI—All from *Sylvilagus floridanus,* Jan. 15-28, 1943, from these counties: *Linn,* 1; *Carroll,* 1; *Laclede,* 1; *Jasper,* 1; and *Pemiscot,* 1.

A Comparison of Larval *T. lipovskyi* with *T. whartoni*

TABLE 7

A Comparison of Characters of *T. whartoni* with *T. lipovskyi*

	whartoni	*lipovskyi*
Scutal shape	angular posteriorly	broadly rounded
Scutal punctae	large, few	small, many
Sensillary barbs	minute basal barbs few or absent (except Arkansas specimens)	numerous pronounced barbs.

I am in agreement with Brennan and Wharton (1950) in recognizing *T. whartoni* and *T. lipovskyi* as separate species. They are separable on scutal and sensillary characters as indicated in figures 19-23 and table 7.

In Douglas County, Kansas, these two species are similar in the means of the length of the posterolateral setae as shown in table 10; *T. whartoni* measures approximately 73 μ, while *lipovskyi* measures 74 μ. By contrast, in Polk County, Arkansas, the two species differ considerably in mean PL length.

Trombicula whartoni from Polk County, Arkansas, are similar to *T. lipovskyi* in having pronounced barbs on the sensillae; these *whartoni* have seven to eleven while *lipovskyi* have ten to seventeen

barbs. However, these two species from this area differ in the scutal shape and punctae as indicated in figures 22-23. Furthermore, the means of the lengths of the PL setae differ; *whartoni,* 73 μ, *lipovskyi,* 79 μ.

A comparison of the means of the PL (table 9) between the areas studied indicates that the length of the PL of *lipovskyi* varies considerably, while *whartoni* shows little variation.

In northeastern Kansas the seasonal occurrence of *T. whartoni* overlaps the peak of the season of *T. lipovskyi.* Both species seem to appear approximately at the same time, in early October, and reach their greatest abundance in November to mid-December. Larval *lipovskyi* continue to be present on the hosts until April, whereas *whartoni* apparently disappear much earlier. This apparent absence of *whartoni* after mid-December may be due to insufficient host examinations.

Trombicula lipovskyi is the most common and widespread *Neotrombicula* in northeastern Kansas, having been taken from a greater number of individuals and species of mammalian hosts and in larger numbers than either *T. whartoni* or *T. sylvilagi.*

While *whartoni* has been taken only from hosts associated with woodland areas, *lipovskyi* has been taken from both woodland and grassland hosts in northeastern Kansas.

A comparison of the numbers of larval *Neotrombicula* collected from birds in northeastern Kansas indicates that *whartoni* is considerably more prevalent on birds than *lipovskyi.* Eighteen of a total of 133 *whartoni* collected in this area were on birds while only ten out of thousands of *lipovskyi* were from birds.

UNGROUPED SPECIES

Five species with various combinations of the long whiplike setae on the segments of leg III have not been placed into any named groups. Only one of these, *T. sylvilagi,* has been collected from the states included in this paper.

Trombicula (*Neotrombicula*) *sylvilagi* Brennan and Wharton

Figure 2.

Trombicula (*Neotrombicula*) *sylvilagi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, 1950, no. 1, pp. 186-187, type: Rocky Mountain Laboratory no. 23242, Leavenworth Co., Kans., *Sylvilagus floridanus,* Oct. 7, 1946. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

Diagnosis. An ungrouped species with the larval characters as follows: two mastitibialae III and two mastitarsalae III; three

genualae I; palpal femur and genu each with one nude seta; galeal seta nude.

Geographic range. This species is known from northeastern Kansas (Jefferson, Leavenworth, Douglas, and Miami counties) and central Illinois (Piatt County).

Seasonal occurrence. Larvae have been taken on chigger samplers as early as August 16 and as late as December 11 in Douglas County, Kansas. The earliest host record is October 5 (Douglas County, Kansas), while the latest is November 21 (Jefferson County, Kansas).

Habitat. Several plots on the University of Kansas Natural History Reservation have been sampled for active unengorged chigger larvae. Two of these plots, one adjacent to the Quarry, called plot A, and another in Skink Woods, along Upper Skink Ledge, called plot B, were found to have *Neotrombicula.* A description of the Natural History Reservation with a map indicating the location of Skink Woods and the Quarry is given by Fitch (1952).

Plot A comprises a total area of approximately 50 square feet. It is situated on a southeast facing slope. Directly adjacent to the west of this area is the open Quarry, which becomes hot, tending, therefore, to raise the temperature of this plot. The principal trees in the vicinity are elms, dogwood, and hickory.

Plot B, approximately 30 square feet in size, is situated on a west facing slope and tends to be cooler and more humid than the Quarry area. Extending over the southern part is an overhanging log (Rat Log) with grass and debris present beneath it. Above the ledge are gooseberry shrubs, walnut, and hackberry trees; below and along the ledge are American elms and *Rhus aromatica.*

Both of these plots are situated on the partially shaded forest floor just below limestone ledges. The well-drained soil of the forest floor covers a limestone derived substrate. The ground cover includes forest litter with a leaf cover present during the fall and winter. The ground in both areas inclines downward from the ledge into the woods. Above the ledge the terrain is level and the trees, which extend but a short distance, are replaced by open grassland. Situated in crevices of the limestone ledges above each of the two areas where *Neotrombicula* were found were *Neotoma* nests.

During the periods of the greatest abundance of *T. sylvilagi,* collections were made in additional areas. These included such habitats as deep within a large cavity at the base of a chestnut oak tree,

on and around a decomposing log deep in the woods, and in grass covered areas adjacent to the woods.

Seasonal abundance. The number of active larval chiggers present was determined by placing several black, rectangular "Plexiglass" chigger samplers (5½ x 2½ x ¼ inches)[9] on the areas to be sampled. They were placed firmly on the ground for one or two minutes at the warmer temperatures and five or more minutes during the colder weather. Some samplers were placed on the leaf litter

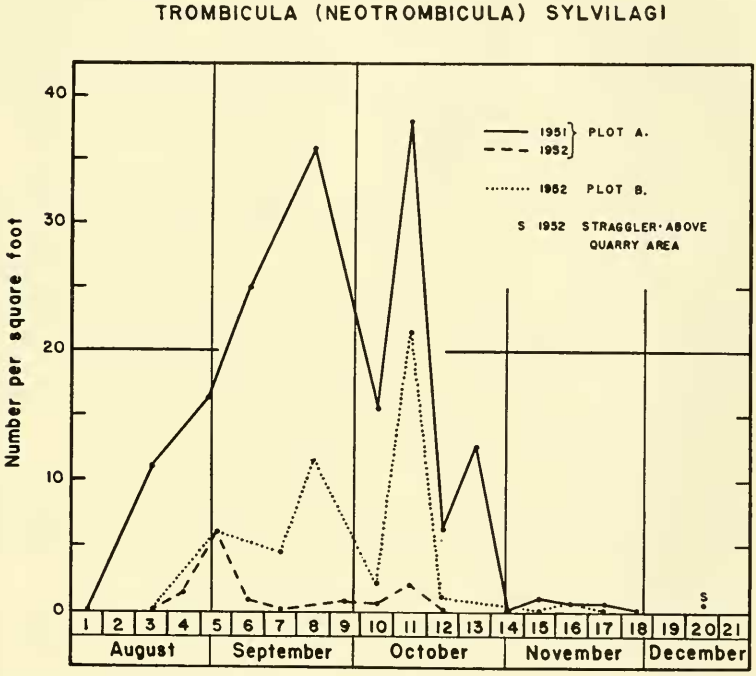

FIG. 2. The estimated number of larval *T. sylvilagi* per square foot, based on larvae taken on chigger samplers, at the University of Kansas Natural History Reservation.

during the height of the larval season for comparison with those placed below; only a slight difference was noted in the abundance of active chiggers. Samples were taken throughout the year; from late spring through fall samples were usually made every one or two weeks, less frequently the rest of the year. The results of the sampling of *T. sylvilagi* are summarized in figure 2. During 1952,

9. This procedure was initiated in 1949 by R. B. Loomis and subsequently followed by him as well as the author (1951 and 1952).

both plots A and B were sampled, while in 1951 only plot A was sampled.

The earliest record of a larval *T. sylvilagi* taken from the soil surface is Aug. 16, 1951. The larval population reached the greatest abundance from early September to mid-October, and rapidly declined until it apparently disappeared by mid-December (latest, December 11, 1952).

The year 1951 was one of the wettest years recorded in eastern Kansas, the rainfall being 15 inches above the normal in Lawrence, and the mammal population during the summer and fall was high, according to Dr. Henry S. Fitch of the University of Kansas Natural History Reservation. Contrary to 1951, the same period (summer and fall) of 1952 was one of the driest on record, with the mammal population dropping extremely low.

During the wet year of 1951, the larval *sylvilagi* were abundant. The few samples made in the plot A station during the months of September and October in 1949 and 1950 indicate that this species was also abundant then; however, the larvae apparently decreased in number more rapidly in these two years than in 1951. The 1952 *sylvilagi* population was considerably below that of 1949 to 1951, probably due to the extremely dry summer and fall. I cannot satisfactorily account for the sharp drop which occurred during the first week of October (week 10 in figure 2).

A single emaciated *sylvilagi* (KU 4794) was collected on December 11, 1952 (see fig. 2) on a sampler placed in a dead grass (*Bromus japonicus*) habitat located immediately above the quarry and adjacent to woodland. This individual appears to have been a straggler and in the larval stage for some time.

The number of chiggers per square foot indicated in figure 2 was obtained as follows: the number of chiggers taken from an area each week was divided by the number of samplers placed on the ground in that area and multiplied by ten (ten chigger samplers cover approximately one square foot). Usually six to eighteen samples were taken. This is not to imply that the entire area has this population, but only the favorable habitats for *sylvilagi*.

Post-larval development. Twenty-two unengorged *T. sylvilagi* (field no. RL 521008-10, collected in the field on chigger samplers) were placed on a juvenile *Mus musculus* which was then placed over water containing a synthetic detergent. At the end of three days ten engorged chiggers had been recovered from the water. These ten chiggers were placed together in a Syracuse watch glass

TABLE 8

Scutal Measurements (in microns)

Locality	No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
T. autumnalis											
Dolores County, Colo.	KU 4003 KU 4004	72 73	92 97	38 35	31 30	32 33	32	48	45	65	....
Dundy County, Neb.	10	70[10] 65—76[11]	91 88—95	33 31—36	30 28—33	29 26—31	30 28—33	48 41—51	46 42—48	67 61—71	76 70—81
T. subsignata											
Carbon County, Wyo. and Boulder County, Colo.	6	71 65—75	90 77—102	29 25—31	24 22—26	30 28—33	26 23—28	38 36—39	34 31—37	43 42—44	61 (4) 58—68
Taney County, Mo.	1	68	82	28	22	28	23	33	36	40	62—
T. microti											
Summit County, Utah	5	73 71—76	97 95—100	30 28—31	36 36—38	29 28—30	33 31—34	45 40—48	42 39—48	60 55—67	72 60—80
Carbon County, Wyo.	10	77 75—82	98 94—105	30 25—33	32 31—36	29 27—31	30 26—34	48 (8) 43—51	46 41—50	57 51—64	80 (6) 77—84

10. The average of the measurements.
11. Extremes.

TABLE 8—Continued

T. harperi

Locality	No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Washakie County, Wyo.....	10	76 71—84	93 90—95	30 27—31	33 31—36	27 23—28	26 22—30	44 41—48	44 39—50	55 51—59	83 70—84
Carbon County, Wyo.....	10	78 72—89	99 89—114	32 26—41	33 30—36	26 24—29	29 26—32	47 44—49	48 41—50	59 56—64	82 78—87
San Juan County, Colo.....	10	82 73—87	102 97—107	34 31—38	34 31—38	27 22—29	29 26—33	51 45—57	50 42—58	64 61—68	86 80—105
T. browni											
Washakie County, Wyo.....	10	80 72—84	100 95—105	29 28—31	38 36—40	28 26—31	31 28—36	49 42—55	45 39—49	53 43—67	89 77—98
T. loomisi											
Yuma County, Colo. and Dundy County, Neb.....	7	72 69—76	93 89—95	28 27—30	34 32—35	19 17—21	29 28—31	44 (5) 40—47	47 43—52	56 51—60	99 (3) 94—103
T. finleyi											
Dolores County, Colo.....	Holo. Para.	69 68	89 91	28 28	30 33	27 23	29 29	41 42	46 41	50 45	90 .....
T. richmondi											
Polk County, Ark.....	1	76	87	28	39	23	28	51	49	75	85—

TABLE 8—Concluded

T. lipovskyi

Locality	No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Norton County, Kan.	10	67 62—77	82 77—94	26 22—31	36 32—39	23 21—27	28 26—32	47 43—51	48 45—54	70 67—75	84 77—91
Douglas County, Kan.	10	68 65—72	84 80—87	26 24—28	38 36—41	26 23—28	30 26—33	50 49—55	50 48—54	73 69—78	89 80—97
Cleveland County, Okla.	10	66 61—68	80 77—85	26 23—29	36 34—39	24 21—26	29 26—31	49 45—54	50 45—57	75 71—79	90 82—99
Washington County, Ark.	10	72 82—65	89 84—93	28 26—31	39 36—42	25 22—28	32 28—35	55 53—60	57 51—63	82 80—89	95 83—104
Polk County, Ark.	10	69 63—72	85 80—91	26 24—28	39 37—42	25 22—27	31 28—33	51 48—56	55 49—66	77 71—84	94 80—121
T. whartoni											
Dundy County, Neb.	4	72 71—72	86 83—88	28 26—28	39 38—41	27 25—28	29 26—32	48 46—50	52 50—58	74 70—77	85 76—100
Douglas County, Kan.	10	67 60—74	83 78—89	26 24—28	38 36—41	25 23—28	28 26—30	46 40—51	52 43—59	75 68—80	87 80—100
Polk County, Ark.	10	65 62—69	77 75—80	25 23—28	37 36—38	24 23—28	26 23—28	45 40—50	49 47—53	73 71—77	89 82—93
Orange County, N. C.	7	68 65—72	83 78—85	27 25—31	37 36—38	23 21—25	28 26—32	47 42—50	51 45—56	72 70—77	90 87—96

TABLE 9

Comparisons of the Lengths of the Posterolateral Setae of Larval *Neotrombicula* from Different Localities

County and State	No.	Mean ± S.E.[12]	Observed range [12]	Coeff. of variation ± S.E.
T. lipovskyi				
Norton Co., Kan.	71	69.5 ± 0.42	56.5—77.8	5.1 ± 0.43
Douglas Co., Kan.	150	73.7 ± 0.31	66.4—83.4	5.1 ± 0.29
McClain-Cleveland Cos., Okla.	38	73.7 ± 0.45	69.2—80.6	3.7 ± 0.42
Washington Co., Ark.	35	83.4 ± 0.73	74.9—94.8	5.2 ± 0.62
Polk Co., Ark.	59	79.1 ± 0.48	70.7—87.7	4.6 ± 0.42
T. whartoni				
Douglas Co., Kan.	45	74.8 ± 0.56	67.8—80.6	5.0 ± 0.53
Polk Co., Ark.	16	73.1 ± 0.59	69.2—76.3	3.2 ± 0.57
T. harperi				
Washakie Co., Wyo.	68	55.1 ± 0.38	45.1—65.0	5.7 ± 0.43
Carbon Co., Wyo.	84	60.1 ± 0.32	53.6—66.4	4.9 ± 0.38
Rio Blanco Co., Colo.	68	63.6 ± 0.40	55.0—70.7	5.2 ± 0.45
Boulder Co., Colo.	130	62.3 ± 0.25	53.6—72.1	4.8 ± 0.30
Gunnison Co., Colo.	6	61.7 ± 1.06	57.9—65.0	4.2 ± 1.21
Saguache Co., Colo.	4	62.8 ± 1.88	59.3—67.8	6.0 ± 2.12
San Juan Co., Colo.	51	64.3 ± 0.44	59.3—72.1	4.9 ± 0.49
T. microti				
Carbon Co., Wyo.	9	56.9 ± 1.23	51.1—63.9	6.4 ± 1.51
Summit Co., Utah	40	60.3 ± 0.53	55.0—67.8	5.6 ± 0.63
T. browni				
Washakie Co., Wyo.	10	52.7 ± 2.05	43.3—66.7	12.3 ± 2.71

12. All measurements in microns.

with water and detergent and kept in the refrigerator for approximately 2 days; following this they were placed in a culture tube at room temperature. In approximately eleven days (range seven to thirteeen) the six surviving larvae entered the prenymphal stage which was completed in approximately 15 days (range 14 to 17 days) by four individuals. Three of the nymphs were preserved while the fourth remained active for 18 days before becoming inactive and apparently entering the preadult stage; this compares with 21 to 43 days for *T. lipovskyi*. This last individual was preserved after three days of inactivity.

Specimens examined. Total number 239, as follows: KANSAS—*Jefferson County:* ½ mi. E, 5½ mi. N Lawrence, *Colinus virginianus*, Nov. 21, 1951, KU 4655. *Douglas County:* Univ. Kans. Nat. Hist. Res., *Cryptotis parva*, KU 4631-32—*Microtus ochrogaster*, KU 4638-49 (19)—*Mus musculus*, KU 4651-54—*Peromyscus manicu-*

latus, KU 4628-30, 4635, 4650—*Zapus hudsonius*, KU 4633-34, 4636-37—*Microtus ochrogaster*, KU 4745-47 (6)—*Peromyscus leucopus*, KU 4748-50, Oct. 16-20, 1951-1952—*Richmondena cardinalis*, KU 4623 and *Junco hyemalis*, KU 4621, collected Nov. 9, 1947 —*Chigger samples*, Sept. 24, 1949 (5 specimens), Oct. 10, 1950 (3), Aug. 16-Nov. 21, 1951 (76), Aug. 27-Dec. 11, 1952 (97); near Nat. Hist. Res., *Neotoma floridana*, Nov. 15, 1952, KU 4795-97; North Lawrence, *Turdus migratorius*, Oct. 5, 1947, KU 4622. *Miami County:* 3 mi. E, 1 mi. S Fontana, *Sciurus niger* and *carolinensis*, mixed skins, Oct. 12, 1948, KU 4624-26, 4741-44 (10).

CLASSIFIED LIST OF HOSTS OF NEOTROMBICULA FROM THE CENTRAL UNITED STATES [13, 14]

AVES

Galliformes
- *Colinus virginianus* (bob-white quail) *T. sylvilagi*

Charadriiformes
- *Capella gallinago* (Wilson's snipe) *T. subsignata*

Strigiformes
- *Asio otus* (long-eared owl) *T. lipovskyi*

Piciformes
- *Centurus carolinus* (red-bellied woodpecker) *T. lipovskyi*

Passeriformes
- *Cyanocitta cristata* (blue jay) *T. whartoni**†
- *Parus atricapillus* (black-capped chickadee) *T. lipovskyi*
- *Parus bicolor* (tufted titmouse) *T. whartoni*
- *Turdus migratorius* (robin) *T. sylvilagi*
- *Sturnella neglecta* (western meadowlark) *T. lipovskyi*
- *Richmondena cardinalis* (cardinal) *T. lipovskyi, T. sylvilagi, T. whartoni*
- *Junco hyemalis* (slate-colored junco) *T. harperi*†, *T. sylvilagi, T. whartoni*
- *Zonotrichia albicollis* (white-throated sparrow) *T. whartoni**†
- *Zonotrichia querula* (Harris' sparrow) *T. whartoni*
- *Melospiza melodia* (song sparrow) *T. lipovskyi*

MAMMALIA

Marsupialia
- *Didelphis marsupialis* (Virginia opossum) *T. lipovskyi*

Insectivora
- *Blarina brevicauda* (short-tailed shrew) *T. lipovskyi*
- *Cryptotis parva* (least shrew) *T. sylvilagi*

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13. Includes the following states: Utah, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Missouri, and Arkansas.

14. Items marked by an asterisk (*) are from Brennan and Wharton (1950). Those marked with a (†) are listed in Wharton and Fuller (1952). The chiggers are listed after the common names of the hosts.

Lagomorpha

Ochotona princeps (pika) *T. harperi†, T. microti†*

Lepus californicus (black-tailed jackrabbit) *T. lipovskyi*

Sylvilagus floridanus (eastern cottontail) *T. lipovskyi†, T. whartoni†, T. sylvilagi*†*

Rodentia

Citellus lateralis (golden-mantled squirrel) *T. harperi†, T. subsignata†*

Tamiasciurus hudsonicus (red squirrel) *T. browni†, T. harperi†*

Sciurus carolinensis (eastern gray squirrel) *T. lipovskyi, T. whartoni†*

Sciurus niger (eastern fox squirrel) *T. whartoni, T. lipovskyi†*

Sciurus carolinensis and *S. niger*[15] *T. sylvilagi*

Reithrodontomys fulvescens (fulvous harvest mouse) *T. whartoni*

Reithrodontomys megalotis (western harvest mouse) *T. autumnalis, T. lipovskyi, T. loomisi*

Peromyscus leucopus (white-footed mouse) *T. lipovskyi, T. sylvilagi, T. whartoni, T. richmondi*

Peromyscus maniculatus (deer mouse) *T. browni†, T. harperi†, T. lipovskyi, T. loomisi, T. sylvilagi, T. whartoni*

Sigmodon hispidus (hispid cotton rat) *T. lipovskyi, T. whartoni*

Neotoma cinerea (bushy-tailed wood rat) *T. autumnalis, T. finleyi, T. harperi†, T. microti†*

Neotoma floridana (eastern wood rat) *T. lipovskyi†, T. sylvilagi, T. whartoni*

Neotoma mexicana (Mexican wood rat) *T. harperi*

Neotoma micropus (southern plains wood rat) *T. lipovskyi*

Phenacomys intermedius (mountain phenacomys) *T. harperi, T. microti*

Clethrionomys gapperi (boreal red-backed vole) *T. harperi†*

Microtus longicaudus (long-tailed vole) *T. browni, T. harperi†, T. microti*

Microtus montanus (mountain vole) *T. harperi, T. microti*

Microtus ochrogaster (prairie vole) *T. autumnalis, T. lipovskyi T. sylvilagi, T. whartoni*

Microtus pennsylvanicus (meadow vole) *T. autumnalis, T. harperi*†, T. whartoni†*

Microtus richardsoni (Richardson's vole) *T. microti*†*

Microtus (Pitymys) pinetorum (pine vole) *T. lipovskyi*

Rattus norvegicus (Norway rat) *T. lipovskyi*

Mus musculus (house mouse) *T. lipovskyi, T. loomisi, T. sylvilagi, T. whartoni*

Zapus hudsonius (meadow jumping mouse) *T. browni, T. harperi, T. sylvilagi*

Zapus princeps (western jumping mouse) *T. harperi, T. microti, T. subsignata*

Carnivora

Canis latrans (coyote) *T. lipovskyi†*

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15. Skins from which this chigger was taken were mixed.

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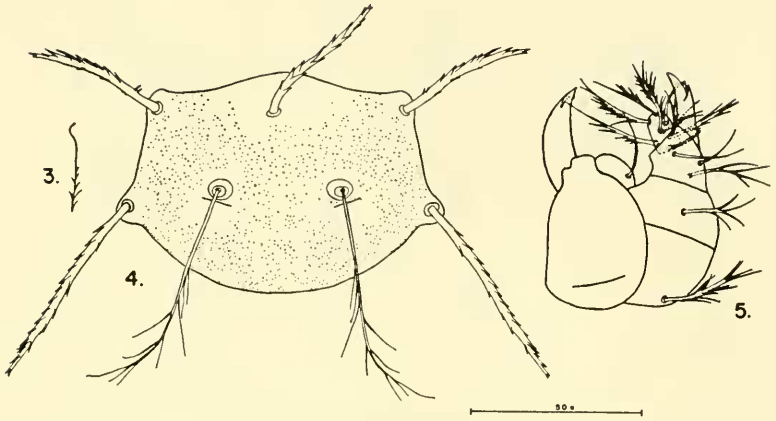
FIGS. 3-6. *Trombicula (Neotrombicula) autumnalis.*

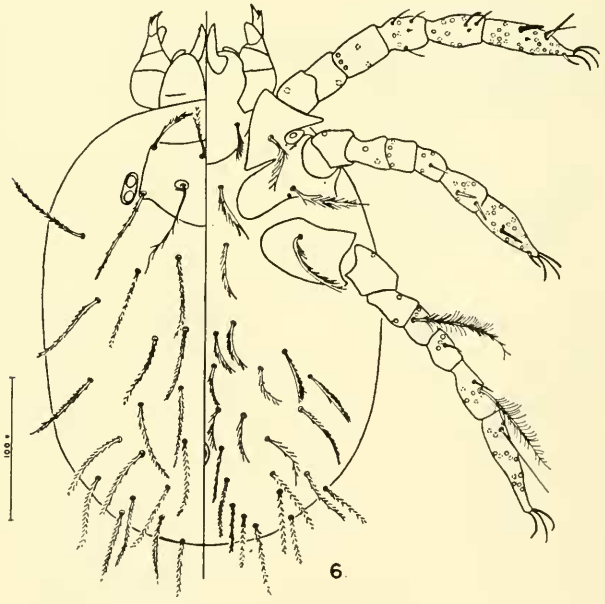
FIG. 3. Apex of the sensilla (KU 4003, Dolores County, Colorado).

FIG. 4. Scutum (KU 4003, from Dolores County, Colorado) and sensilla (KU 5826, Dundy County, Nebraska).

FIG. 5. Gnathosoma (Dolores County, Colorado).

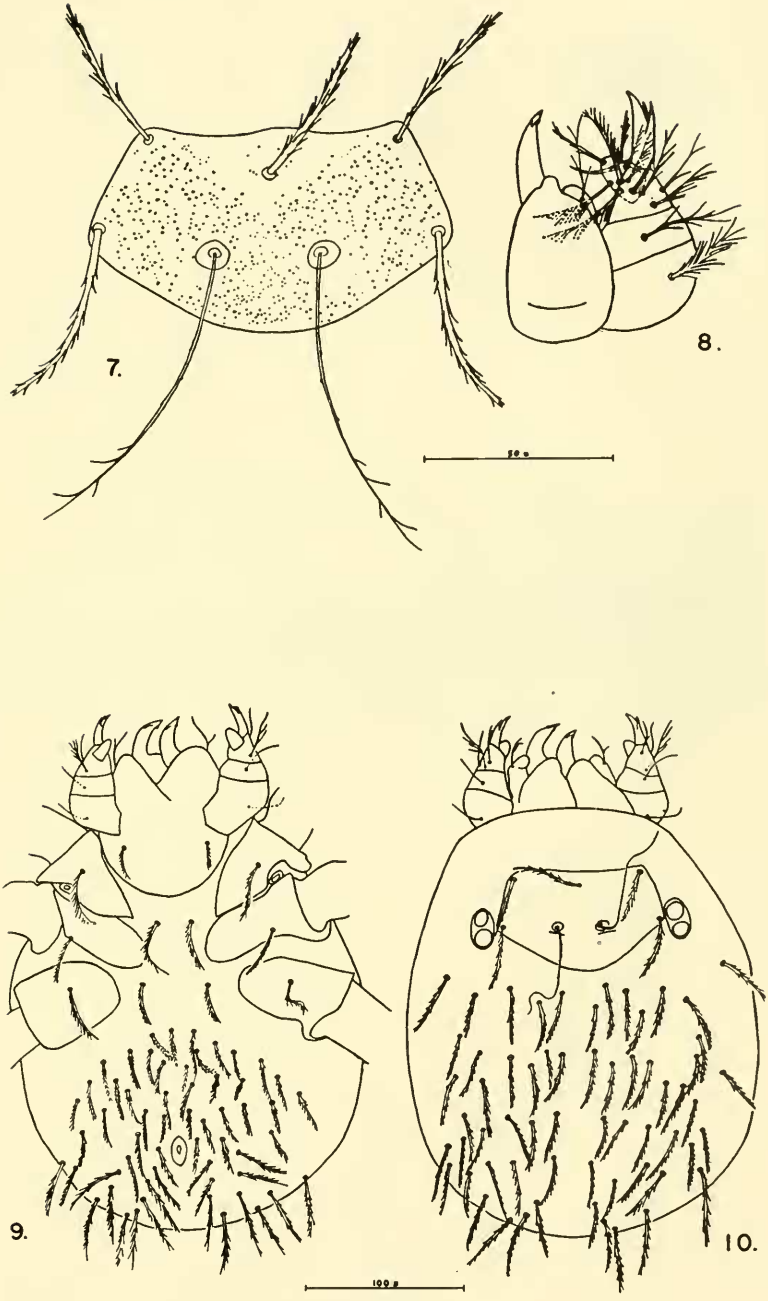
FIG. 6. Body (Dundy County, Nebraska), dorsal view on the left, ventral view on the right; legs (Dolores County, Colorado).





FIGS. 3-6

FIGS. 7-8. *Trombicula* (*Neotrombicula*) *loomisi.*
FIG. 7. Scutum and sensilla.
FIG. 8. Gnathosoma.
FIGS. 9-10. *Trombicula (Neotrombicula) browni.*
FIG. 9. Dorsal view of body.
FIG. 10. Ventral view of body.



FIGS. 7-10

FIGS. 11-15. *Trombicula (Neotrombicula) finleyi.*

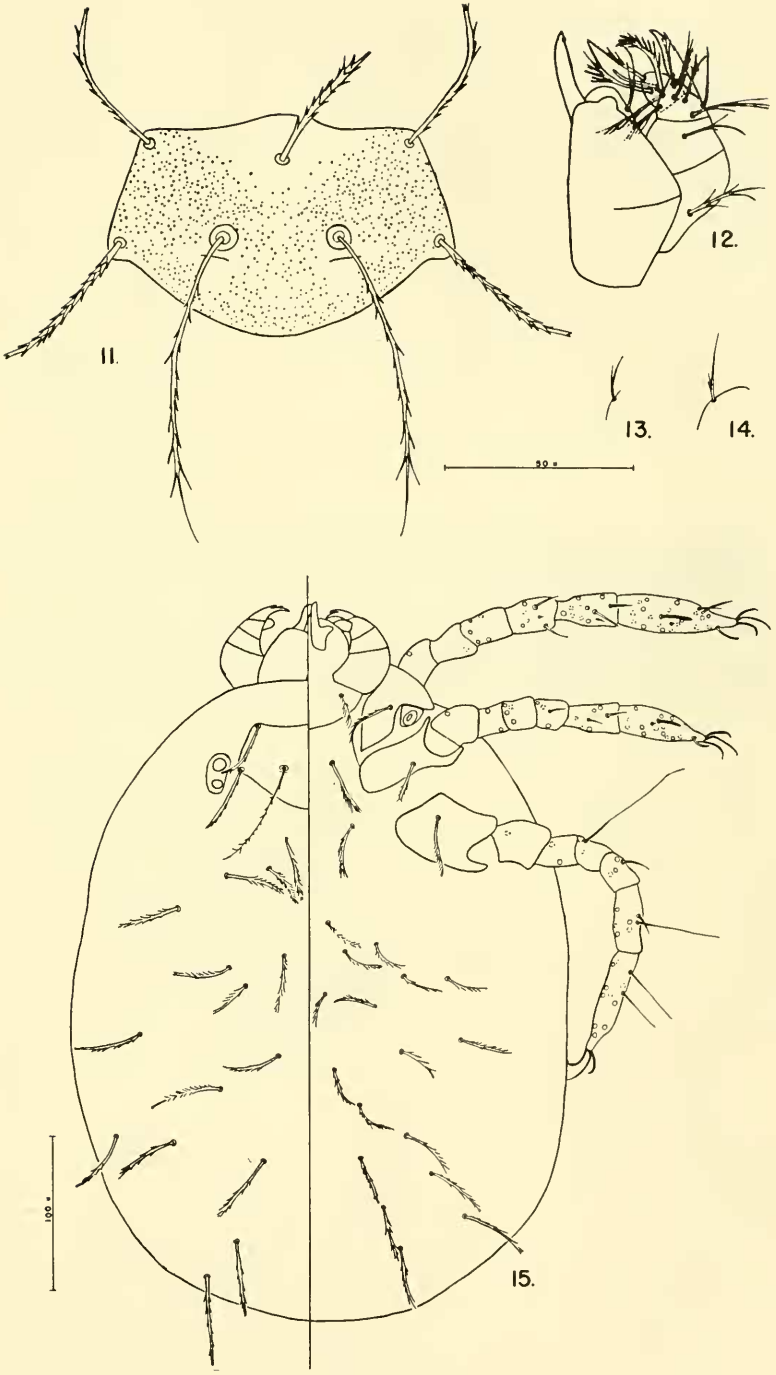
FIG. 11. Scutum of holotype.

FIG. 12. Gnathosoma of paratype.

FIG. 13. Lateral seta of palpal tibia of holotype.

FIG. 14. Galeal seta of holotype.

FIG. 15. Body and legs of holotype, dorsal view of body on the left, ventral view on the right, with the legs showing all nude setae and the bases of branched setae.



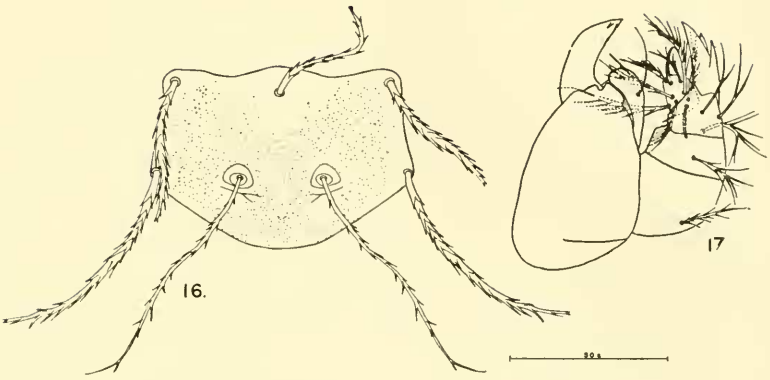
FIGS. 11-15

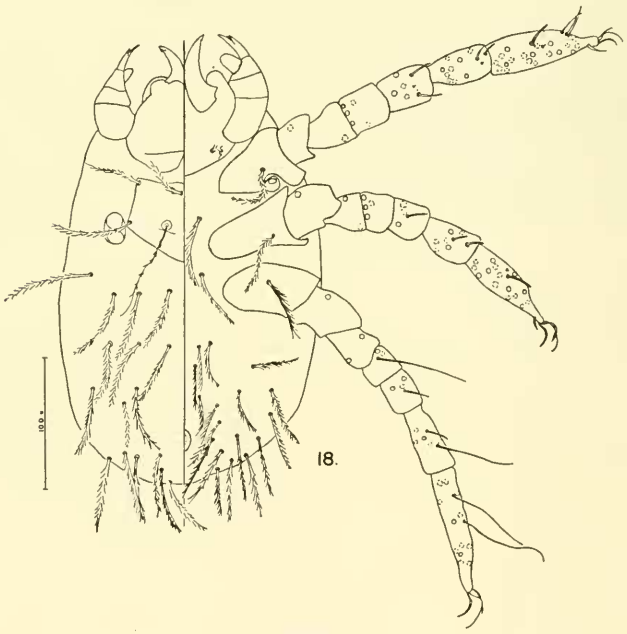
FIGS. 16-18. *Trombicula (Neotrombicula) lipovskyi* (type locality, Norton County, Kansas).

FIG. 16. Scutum and sensilla.

FIG. 17. Gnathosoma.

FIG. 18. Body and legs, dorsal view of body on the left, ventral view on the right, with legs showing all nude setae and bases of branched setae.





FIGS. 16-18

FIGS. 19-22. *Trombicula (Neotrombicula) whartoni.*

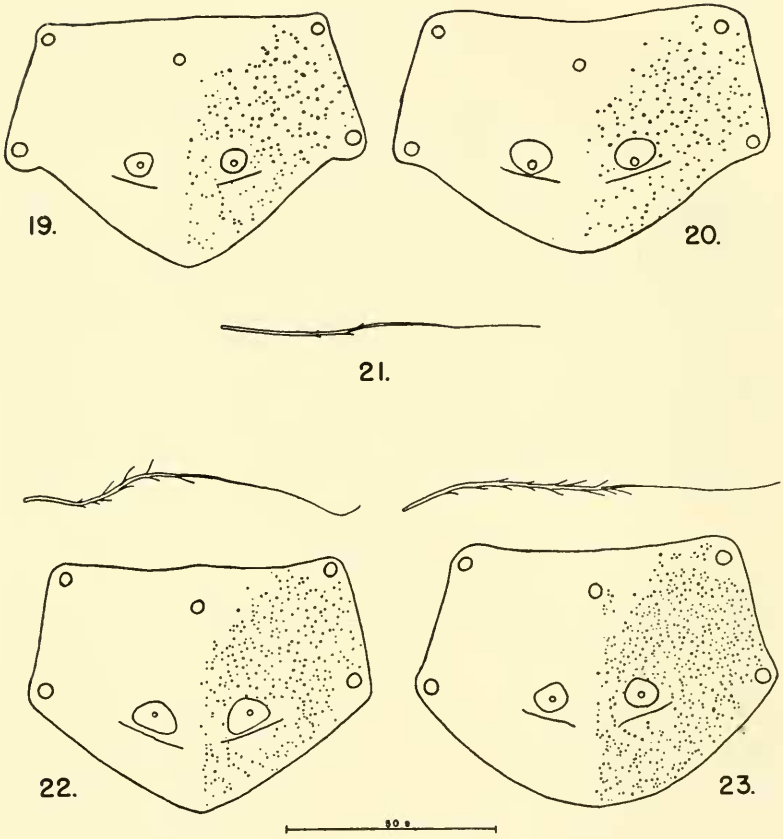
FIG. 19. Scutum (Douglas County, Kansas).

FIG. 20. Scutum (Orange County, North Carolina).

FIG. 21. Typical sensilla in specimens from Dundy County, Nebraska; Douglas County, Kansas; and Orange County, North Carolina, showing the few minute basal barbs present.

FIG. 22. Scutum and sensilla (Polk County, Arkansas).

FIG. 23. *Trombicula (Neotrombicula) lipovskyi.* Scutum and sensilla (Polk County, Arkansas).



FIGS. 19-23